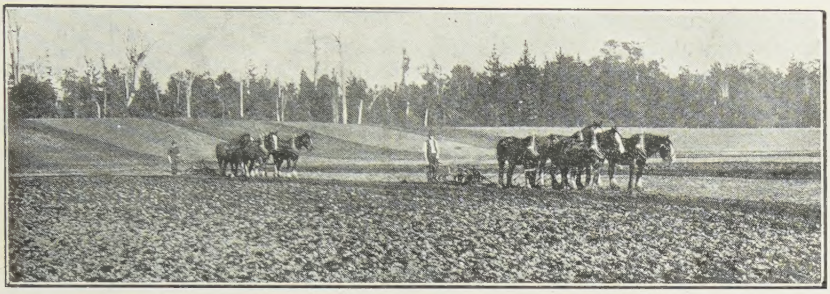

The New Zealand

Journal of Agriculture.

VOL. XXVIII.—NO. 5.

WELLINGTON, 20TH MAY, 1924.

THE GRASSLANDS OF NEW ZEALAND.

SERIES II. THE TARANAKI BACK-COUNTRY.

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3. PRESENT-DAY POSITION OF THE HILL PASTURES AND CONSTITUTION OF THE PASTURE SWARD.

IT has been stated before that the two great factors in weed-control in our grasslands are (1) the formation of a close and continuous grass sward, and (2) the judicious feeding-down of that sward by different classes of stock. The sward of grass functions really in two ways. Firstly, by its actual occupation of the ground it competes with weeds established along with it, and by its cover prevents weed invasion. Secondly, in virtue of the feed it produces stock are enabled to be maintained on the area. Stock judiciously managed are really the most potent agents in the control of weeds, but stock cannot, in justice to themselves, be maintained on the area for long if the grass sward is absent. The grass sward, therefore, is all-important.

Of the Taranaki back-country in general it may be said that there is a very much larger area on the hills covered by secondary growth than by grass (Fig. 32). Along the easy sloping foothills there is usually good grass, but as one ascends the hills the grass turf weakens, herb-like weeds increase, and then one comes into the zones of various

classes of secondary growth, where it may be said that the pasture is non-existent. In a stocked area on such a slope the first zone of secondary growth is usually hard fern dominant, and manuka may be sprinkled among this. Above the hard-fern zone bracken usually predominates until one reaches the ridges, where usually, on the stock trails and camps, there is a good sward of grass. In certain places water-fern may take the place of hard fern.

The more or less zoning of the secondary growth is the outcome of the manner in which stock graze the area. The good grass at the bottom of the slope results from the greater soil-fertility, and from the fact that more stock graze and tread there. Higher up the hillside the bracken-fern has been crushed out as the stock have worked their way up, but the ground bared of this growth has seldom been sown with grasses after or during the crushing, and consequently weeds largely predominate. The area may be one mass of piripiri. Almost all the bracken-fern areas of this country have gone through a phase in which hard fern previously existed. A smother of bracken for several years will kill out hard fern (see *Journal*, September, 1923, pp. 148–151), but should the bracken be crushed out while even a vestige of the hard fern remains alive there will be a return of the hard-fern trouble, particularly so where volunteer growth is allowed to populate the soil bared of the bracken growth. If suitable grasses and clovers were sown as the bracken was being crushed out it might be quite a different story. On these slopes, therefore, when the bracken is crushed out as the stock work their way up there is usually a return of the hard fern, which forms a zone, as it were, graduating into pure bracken higher up where stock have not yet wandered (Fig. 32).

In most old pasture areas, where stock graze over the whole paddock, very little bracken may be seen, but here the hard fern is well represented, either as isolated clumps dotted here and there, or numerous patches, or contiguous patches virtually occupying the whole surface. Pastures having from 30 per cent. to 90 per cent. of the sown area covered by hard fern are not uncommon, and, as a rule, with the turf of grass constituted as at present, the hard fern is on the increase. Manuka, again, is spreading, and this spread is due almost entirely to the open nature of the pasture sward. The foregoing applies to the areas poorly farmed. On the better-farmed portions there may be as little as 10 per cent. of secondary growth, some paddocks being virtually clean, but even among the best farmers of the district it is not too much to say that an average of 30 per cent. of the farm is growing nothing but hard fern, manuka, or other rubbish. When the production of these latter farms is considered, the grassland itself, even as at present constituted, must be yielding fairly high (Fig. 33).

CONSTITUTION OF PASTURES KEPT FREE OF SECONDARY GROWTH.

The description of the grasslands given in the following pages applies to the areas that have been kept free of secondary scrub-growth. Nearly all the common grasses and clovers met with in pastures generally can be found in the Taranaki back-country at the present time in greater or smaller amount, but a great many of these have been introduced slowly and only during the past few years. In the early days of felling and sowing this country little else but rye-grass, cocksfoot,

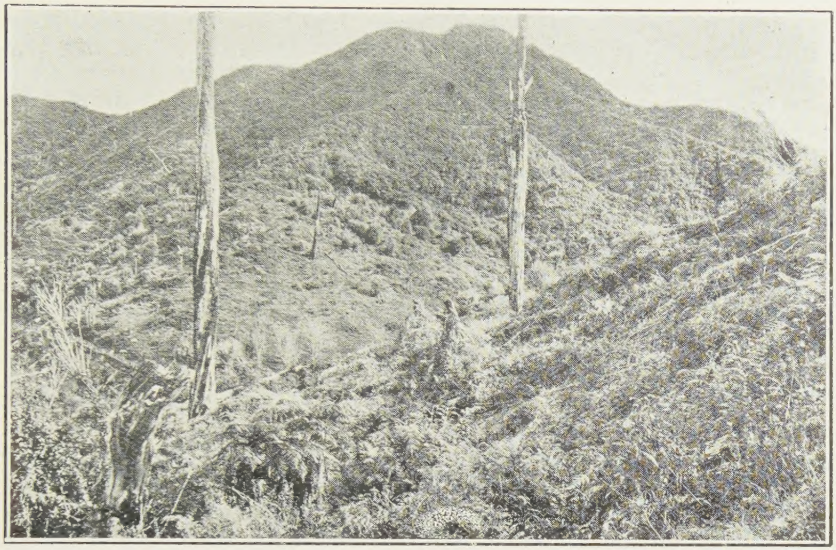

FIG. 32. GENERAL VIEW OF COUNTRY ALMOST ENTIRELY RUN TO SECONDARY GROWTH.

On the easy sloping foothills, in the middle distance, may be noted good grass comparatively free of scrub growth. Higher up, where the bracken has been crushed out, is a zone of hard fern and manuka, and above to the top a mass of bracken-fern.

FIG. 33. TYPICAL HILLSIDE OF RATHER WELL FARMED COUNTRY AS REGARDS STOCKING.

On the easier, better grassed portions there is scarcely any hard fern, but on the steeper, poorer faces the patches are almost contiguous.

[*Photos by E. Bruce Levy.*

and red and white clover were used. Later sowings included some of the other better grasses such as timothy, crested dogstail, meadow-foxtail, Poa trivialis, and Poa pratensis; and a sprinkling of these even might have been sown on the very early burns. It is only recently that the farmers of the district have appreciated the need of introducing the second-class grasses—brown-top, Danthonia pilosa, &c.; but even yet many still pin their faith to the better English grasses such as cocksfoot and rye-grass. One farmer on being questioned as to what he was sowing on his bush-burn exclaimed, "The old Scotch mixture—a lot of rye with a bit of cocksfoot thrown in"; and in certain recent burns examined by the writer undoubtedly the bulk of the grass-growth is cocksfoot and rye-grass. In his opinion it is largely the lack of the finer close-turf-forming grasses that has led to so much going back of the country to secondary growth.

For the present-day farmer who does not include the finer* grasses in his mixture one can have little sympathy; but the pioneer settlers of the Taranaki back-country cannot in any way be blamed for their omission, for certainly the great forest-growth and the remarkable early productivity of the hill pastures gave indication and promise of a wonderful fertility, so that it appeared then almost criminal even to suggest the poorer, second-class, finer grasses, in view of the so prolific growth of the better English species. The wonderful growth of the clovers also led further to the belief that the Taranaki back-country was eminently suited for the first-class grasses and clovers. The writer claims that this country is still good potential grassland, although the farmer there must needs come to realize that the finer second-class grasses and clovers must be included to take up the running as the better grasses and clovers weaken and go out. Again, the grasses themselves must be considered more and more. In this there are three important aspects to consider with regard to each species: (1) Its growth-form, (2) its soil-fertility requirement, and (3) its response to different methods of utilization of herbage produced—grazing by different classes of stock, haying, burning, &c.

A typical old hill pasture of the Taranaki back-country where such has not gone to secondary growth appears but poorly constituted. In general the sward is open, cocksfoot predominating, but nowhere does this grass under grazed conditions by itself form a close compact turf. Excepting where the "heart" has been grazed out of the pasture the original cocksfoot seeding is holding, although the individual plants are not robust, particularly so where no spelling of the pasture has been done. According to the quality of the soil and treatment of the sward the interspaces between the cocksfoot plants are filled with different classes of growth. On the light open knolls

* This term has come into general use among farmers to indicate the finer-foliage grasses that have been used to fill up, making a fine, compact turf. No doubt the term arose from a consideration of the extremely fine foliage of Chewings fescue, which has been used for years in the hill-country pastures. The term is now meant to include such grasses as brown-top, danthonia, &c., although these at times are not particularly fine in the foliage. In general, the "finer" grasses are close-turf-forming grasses, and really it is the close-turf-forming attribute rather than the fine foliage that makes these grasses important. Accepting this definition it will be seen that a coarse-foliage grass like paspalum may even be included as one of the "finer" grasses.

the cocksfoot is extremely poor, dried out, and stunted, and the interspaces are here usually large and occupied by catsear (Fig. 34). Almost pure associations of catsear may be found on these drier knolls; Poa pratensis may also figure somewhat here, but its growth is sparse and open. Certain of these knolls also may be occupied by a dark-brown coloured, short, stiffly erect moss, which precludes almost all other plant-growth. Occasionally in these places, also, other grasses are met with; Chewings fescue, and a fine-leaved, sparse vegetative form of danthonia—*D. semiannularis* var., more or less peculiar to the district—may be found, and often the initial stages of a Danthonia pilosa invasion are being enacted. Danthonia pilosa will prove successful against all present occupiers of these knolls as time goes on. In a general hillside pasture of the Taranaki back-country it can be said, however, that such knolls occupy only a small proportion of the area.

FIG. 34. TYPICAL PIECE OF TURF ON POORER ASPECT OF COUNTRY WHERE ONLY COCKSFOOT, RYE-GRASS, AND CLOVERS HAVE BEEN ORIGINALLY SOWN.

The interspaces are here filled largely by catsear. In these places the poorer grasses are essential to the formation of a closed turf.

[*Photo by E. Bruce Levy.*

The general surface slope is of a better quality. On these better portions cocksfoot still largely predominates, and the sward again is usually open, bare ground still showing through. Here almost invariably the cocksfoot is associated with Poa pratensis, but these two alone do not form on the average slopes a close and continuous sward. In places yarrow assists, and here almost a closed turf is obtained. In many pastures Yorkshire fog is extremely common, and certainly it must be contributing largely to the productivity of the grassland. Yorkshire fog, however, keeps on dying out, and this means again an opening of the pasture sward. Crested dogstail in

certain sowings—particularly so in the old Government sowings made over twenty years ago—is persisting, and on these fair average slopes it is, as one would expect, associating well with the cocksfoot. Odd plants of timothy may persist there too. White clover may often be present associated with the foregoing grasses, but it is not doing well excepting where the pasture is well grazed, tramped, and consolidated by stock. Suckling-clover is common throughout, and odd plants of red clover still persist. The weed content of these average slope pastures is often very high. Catsear, rib-grass, cudweed, creeping buttercup, and selfheal may often be present in large numbers, filling in really between the cocksfoot plants, and occupying that position where companion pasture-plants should be thriving. Goose-grass and hair-grass are regular annual weed-grasses, while sweet vernal is commonly met with and is apparently on the increase in many pastures.

Almost invariably where the pastures have been well tramped, consolidated, and manured by stock there is a dense, close, and continuous turf. Perennial rye-grass in such places still persists and thrives, crested dogstail, Poa pratensis, timothy, cocksfoot, and even Poa trivialis are all strong and vigorous ; white clover grows profusely, associating with the grasses and forming really with the latter some of the finest hill-country grasslands in New Zealand (Fig. 35). Unfortunately, however, the areas of these good pastures is small. They are confined mainly to the holding-paddock, special home paddocks, and areas about gateways, along the ridges and camping-places for stock—anywhere, in fact, where stock by heavy treading and manuring consolidate the soil and maintain these areas in a high state of surface-soil fertility (Fig. 36). The importance of this point in the management of pastures will be considered later.

On heavily stocked areas where pasture plants have never been introduced, or else where they at one time or another have been completely tramped out by stock, there may be a prolific weed-growth mainly of selfheal, greater plantain, creeping buttercup, pennyroyal, or mayweed. Poa annua also may be extremely abundant in these places.

Certain other pastures, again, more particularly on the higher country where kamahi was fairly prevalent in the primary forest, may be mentioned—pastures that have been kept well grazed for upwards of twenty years, and where the secondary growth has in one way and another been kept out. Here, associated with the cocksfoot—when the latter has not been entirely eaten out—may be often found a dense sward of New Zealand rice-grass (*Microlaena stipoides*) and danthonia, usually the *D. semiannularis* referred to previously. In other open closely grazed sheep-pastures piripiri is frequently bad.

On the shady faces the grass turf is often extremely poor ; odd cocksfoot-plants still persist, also some crested dogstail, Poa pratensis, and Yorkshire fog, but there is often much moss-growth, and indigenous herbs such as nertera (*Nertera Cunninghamii*), pratia (*Pratia angulata*), and pennywort (*Hydrocotyle moschata*) are common. The turf is usually very open, presenting much bare ground. In some other pastures paspalum is gaining ground, and in such cases virtually no weed-growth occurs, there being formed a close and continuous turf. In the

FIG. 35. TURF OF COCKSFOOT, PERENNIAL RYE-GRASS, TIMOTHY, POA PRATENSIS, AND WHITE CLOVER ON RIDGE USED AS A STOCK TRAIL AND CAMP.

The stock by their treading and dunging have maintained this area up to the standard of fertility demanded by the better grasses, and consequently these are strong and vigorous.

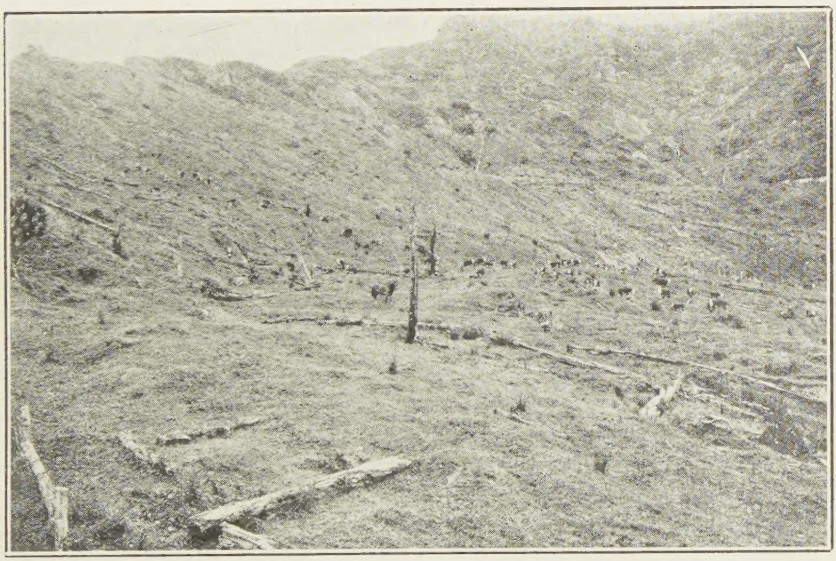

FIG. 36. AREA USED AS A SPECIAL HOME AND HOLDING-PADDOCK ON FARM OF MR. A. COXHEAD, WHANGAMOMONA.

The turf here is close and continuous, with cocksfoot and white clover dominant—an excellent example of what can be accomplished under consolidation and maintenance of fertility by inbrought stock.

[*Photos by E. Bruce Levy.*

more recent sowings brown-top and Lotus major have been used, and where turfs containing these two species are met with the weed content is again low and a close and continuous turf is the rule. Danthonia pilosa, too, is spreading throughout, particularly so on the drier slopes, and this grass is forming a close even turf virtually free of weeds.

IMPORTANCE OF THE FINER SECOND-CLASS GRASSES.

Of the old hillside pastures of the Taranaki back-country, then, with a few exceptions it may be said that the pastures are poorly constituted. It is not that the soil is lacking in quality so that a close turf cannot be formed, but rather that too few species of grasses and clovers have been included in the original sowings. The soil surface in its virgin state is too light and too unconsolidated for rye-grass to hold, and cocksfoot, unless bound by other companion turf-forming grasses, either goes out entirely or else becomes dried up and stunted. If these two species, therefore, form the bulk of the mixture sown an open pasture will result in a few years. Then it is that the area becomes a prey to weeds. These two grasses certainly are essential in the seed mixtures, but more and more consideration must be given, both in primary and in secondary burns, to the finer grasses and clovers—brown-top, Lotus major, and Danthonia pilosa being of outstanding importance.

The formation of a closed turf is extremely important, but it is of equal importance that that turf should be constituted by as many suitable pasture species as possible, particularly so at the offset, for if this is so no matter how the pasture is treated subsequently there is bound to be some grass that will thrive under the conditions of management meted out. The great trouble in the past has lain in the constituting of our permanent hill-pastures by species of grasses and clovers that could not persist and thrive there under the severe conditions of close and continuous grazing, and under a state where the surface-soil fertility is being gradually depleted.

SOIL-FERTILITY IN RELATION TO THE VIGOUR OF DIFFERENT PASTURE SPECIES.

The grassland farmer should recognize that every grass and clover that may be used in his pastures has a standard of soil-fertility that must be maintained in order that that species may thrive. This conception, the writer thinks, is of fundamental importance in grassland maintenance. It can be put down fairly definitely that the better first-class grasses such as meadow foxtail, timothy, rye-grass, cocksfoot, &c., demand a higher available soil-fertility than do the poorer second-class grasses, and unless this is maintained these first-class grasses will not thrive and will not produce, under a reduced condition of soil-fertility, as much herbage as will the poorer grasses on that same soil. This fact, of course, is at the root of all succession in our pastures. If the second-class grasses did not thrive better and produce more herbage on these soils than do the first-class grasses there simply would be no replacement of the latter grasses by the former.

If we study certain pastures existing on the different soil-types in New Zealand we find that it is the effort of the farmer to grass soils of varying quality with correspondingly different pasture-species. On

FIG. 37. SHOWING RETURN OF DOMINANCE OF PERENNIAL RYE-GRASS AS A RESULT OF INCREASE IN SOIL-FERTILITY.

The area inside the fence was available as a run-off for sheep from a rape crop growing on the flat. This portion is mainly perennial rye-grass. Outside the fence, with exactly the same turf originally, the fertility is low, and the turf is open, consisting largely of danthonia, Poa pratensis, and stunted cocksfoot and rye-grass.

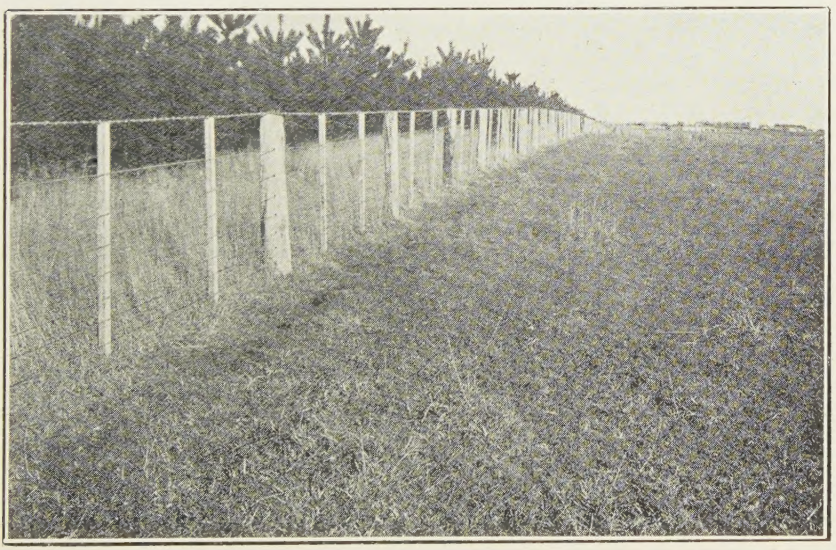

FIG. 38. DOMINANCE OF THE BETTER GRASSES AGAINST POORER ONES UNDER A SYSTEM OF SURFACE-SOIL FERTILITY-MAINTENANCE.

In the paddock (right) is an old sward mainly of cocksfoot, crested dogstail, Poa pratensis, and white clover. Here the soil-fertility has been maintained up to the standard of these grasses by top-dressing with artificial manures. Outside the fence (left) is an unbroken mass of brown-top, seeding profusely. While top-dressing is continued there will be no fear of invasion of the turf inside the fence by brown-top. Taken in Southland.

[*Photos by E. Bruce Levy.*

the damp, very fertile swamps and alluvial plains the effort is to secure a meadow foxtail-Poa trivialis-timothy dominant type of permanent pasture. On soils not quite so damp and fertile perennial rye-grass is almost invariably chosen as the main constituent. On soils just too poor for perennial rye-grass to thrive luxuriantly, cocksfoot, meadow fescue, crested dogstail, and (on the hills) Poa pratensis are the species most commonly used. On the poorest soil-types poorer quality grasses than the foregoing are employed. In the laying-down of these soil types to grass it is fairly safe to say that the farmer will choose for each type the highest yielding and the most palatable of grasses and clovers that it is possible for him to get to thrive there. Therefore, on this assumption, the common grasses can be arranged in their order of merit from a yield *plus* quality of herbage point of view.

When this is done it is found that they run somewhat as follows :— Meadow foxtail, Poa trivialis, and timothy come first ; perennial rye-grass is a good second ; then follow cocksfoot and meadow-fescue associated with crested dogstail and Poa pratensis third ; brown-top is fourth ; Danthonia pilosa fifth ; and about the bottom of the list come Danthonia semiannularis and Chewings fescue. Again, if these groups are examined it is found that the topmost group in the list requires the highest state of soil-fertility, and as we descend so grasses are found that can persist and thrive under poorer and still poorer conditions of soil-fertility.

The important point is that if we have soil up to the standard of fertility required by, say, perennial rye-grass that grass will persist and thrive, and so great will be its growth that none of the poorer grasses below it in the list will have a chance of competing with it (Fig. 37).* Consequently it is found that just so long as the first-class grasses are doing well there is under reasonable conditions of grazing no fear of invasion of that soil by the inferior grasses (Fig. 38). The increasing presence of the poorer grasses in a pasture most certainly indicates that the better grasses sown are weakening and are going out. On a well-farmed hill-pasture it will be found that the poorer species predominate on the drier knolls, which are below the standard of fertility demanded by the first-class grasses. In the damper and richer hollows, on stock camps, &c., the poorer species are scarcely represented at all. Cocksfoot can persist and thrive on soils lower in fertility than will maintain perennial rye-grass, and its persistence against the latter on many of the lighter soils of Taranaki is due largely to the fact that perennial rye-grass demands a state of soil-fertility higher than that prevailing in general throughout these lands.

Certain grasses have a longer range of adaptability to a soil gradually becoming depleted in available surface-fertility than others. Thus meadow foxtail, Poa trivialis, and timothy have quite a short range, and simply will not thrive on poor soils. Cocksfoot has a fairly long range, although its productivity falls off considerably on the poorer soils. Grasses such as paspalum and Yorkshire fog have an extremely long range, in each case the yield being proportional to the fertility of the soil. Even on the poor soils, however, paspalum will in a warm district produce more feed than will the poorer grasses that are at home

* Compare also Figs. 50 and 51, p. 47, Bulletin No. 107, "The Grasslands of New Zealand : Series I. Principles of Pasture-establishment."

FIG. 39. DANTHONIA PILOSA (FINE FOLIAGE ON RIGHT) AND COCKSFOOT (ON LEFT) GROWING TOGETHER ON RATHER A POOR KNOLL.

Danthonia is here easily beating the cocksfoot in yield, the soil suiting it and being below the standard of fertility demanded by cocksfoot.

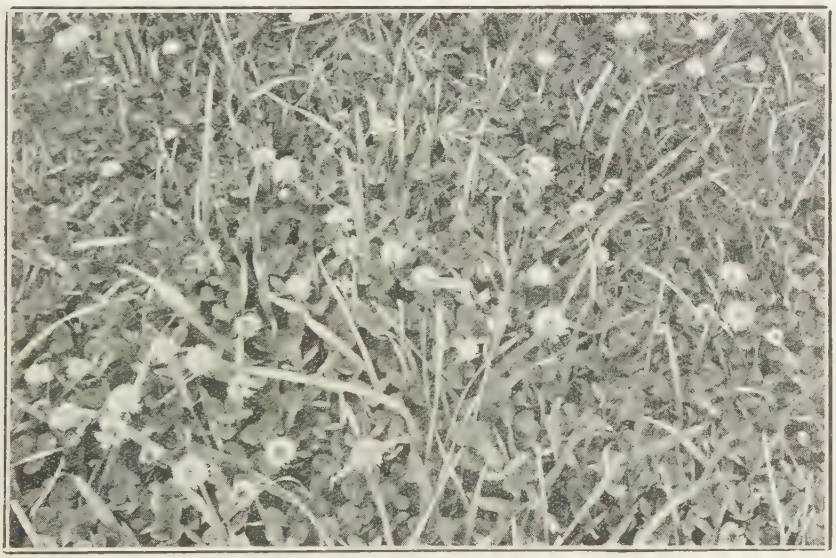

FIG. 40. SOIL MAINTAINED UP TO THE STANDARD OF FERTILITY OF COCKSFOOT AND WHITE CLOVER ON LIGHT LAND.

The sward previously was open, the cocksfoot stunted, and the white clover scarcely in evidence. As soon as the standard of fertility was raised (in this case by artificial manures) the cocksfoot and white clovers came away rapidly, filling up all bare spaces and securing dominance over weeds.

[*Photos by E. Bruce Levy.*

there, but in general this is not true of other grasses. They may persist on the poorer soils in an extremely stunted condition, but their yield there is virtually nil, and consequently the second-class grasses beat them in production (Fig. 39).

In the Taranaki back-country the original fertility of the forest burn was up to the rye-grass and cocksfoot standards, but as the fertility lowered the rye-grass dwindled and the cocksfoot became the dominant element of the pastures. After ten years or so, however, with constant grazing and removal of wool or fat stock from off that area the fertility of much of the hill country became reduced below the standard demanded by cocksfoot, and then this grass also began to wane and weaken and to go out. In most of the original sowings, unfortunately, there were not included grasses which could thrive on soils below the cocksfoot standard of fertility, and thus the pastures became open and ran into weeds. Brown-top demands a standard of soil-fertility between cocksfoot, on the one hand, and Danthonia pilosa on the other. If brown-top and Danthonia pilosa had been added to the mixtures sown the brown-top would have taken up the running on the better soils, and on the country a little too poor for brown-top Danthonia pilosa would have come in. The writer does not think that in the Taranaki back-country any system of grazing could reduce the soil-fertility below that demanded by Danthonia pilosa, and therefore if the latter could only get established throughout the hill country a sward of grass would be virtually assured there for all time. To the writer's mind the possibilities of that country are such as to give promise that better-yielding grasses than Danthonia pilosa can be maintained under a sound system of management, but the danthonia is necessary, for there are always poor spots, dry knolls, &c., that no economic system of farming could bring up to a state of fertility such that the better grasses would yield there higher than Danthonia pilosa. This conception of each grass for its own special habitat defined in terms of soil-fertility is important. The physical nature of the soil, apart from its fertility, the growth-form of the plant, and its response to different methods of grazing, however, are also important and should not be lost sight of.

THE BETTER GRASSES UNDER A REDUCED SOIL-FERTILITY AND THE SECOND-CLASS GRASSES AS PIONEERS.

There is another equally important and fruitful conception in relation to grassland mixtures. If one examines carefully pastures formed even of the poorest grasses, provided there has been a good mixture sown, there will often be found the better grasses—stunted and mere vestiges of their former selves, but yet alive. While there is life in these better species there is hope for the improvement of that pasture, and if the farmer sets to work and raises the standard of fertility of that soil he will find that the better grasses again assert themselves and soon begin to replace the poorer species. This is true only if the better species have been sown and are still alive (Fig. 40). On this argument, however, it might be contended that if it is possible to bring back the first-class grasses it would be better to use only these grasses and keep them going by maintaining the surface fertility. On most ploughable country, of course, this could be done. But there

FIG. 41. LOTUS MAJOR STRUGGLING AGAINST HARD FERN AT WHANGAMOMONA.

Typifying one of the essential plant-forms that must be included in mixtures where there is a struggle against tall aggressive weeds. Sufficient growth has been left standing among the hard fern to entice stock to work on to the patches, and when this can be done the hard fern will be gradually ousted.

FIG. 42. PASPALUM INVASION OF HARD FERN IN THE NORTH AUCKLAND DISTRICT.

Exactly the same object is attained here as in the case of the Lotus major in Fig. 41. Stock are induced to graze among and to tread on the hard-fern patches.

[*Photos by E. Bruce Levy.*

are certain types of country that have to go through a breaking-in phase, as it were, and in order to tide over this phase, which may be one of consolidation or one of weed-suppression, it is often necessary to include in the mixtures poorer grasses that will function while this is being effected. On certain light pumice soils, for example, where consolidation is an important factor, poorer grasses than those one would like to see used there must be included in the original permanent-pasture mixture. It is futile to strive to get a sward of the better grasses to hold on these soils while in an unconsolidated state. Certain of the poorer grasses will hold and form a sward with some plants of the better elements persisting in a mere vestigial condition. When the sward is formed the surface may become consolidated by stock, and then with artificial manures, &c., the fertility may be raised up to the standard of the better grasses. In many cases, therefore, even on ploughable country, the poorer grasses are needed to form a sward so that stock may be held there to effect the consolidation; and then by improvement in surface-soil fertility we may get back to the better grasses. The poorer grasses give a foundation to build upon; without them the better grasses would go out and the pasture would then run to weeds.

In the Taranaki back-country we have a similar breaking-in phase; not only is lack of consolidation an important factor, but there is also the great struggle against secondary growth. If only the hill country of Taranaki could be consolidated all the easier country at least could be brought back to the cocksfoot - crested dogstail - white clover - Lotus major, and even rye-grass type of pasture, a fact amply demonstrated on any stock trail, stock camp, or holding-paddock (Fig. 36). In order to effect this consolidation and to fight against secondary growth poorer elements than one would like to see must be employed—elements, in fact, that will hold under a loose-soil condition; and ones that will endure for some time the shade of the secondary growth, yielding there some feed that will entice stock into such growth (Figs. 41 and 42); or that will carry a fire at a later period. The consolidation of the soil is a slow process where stock alone is the implement of consolidation that the farmer can use. And unless a turf is secured on the virgin loose soils it is not possible to effect any improvement along the lines of consolidation, because the secondary growth will force the stock off the area. Once the soil surface is well grassed, however, it is possible with this as a foundation to proceed to improve the soil-fertility, raising it gradually up to the standard of the first-class grasses. Here, then, can be seen the necessity of sowing along with the brown-top, &c., some seed of these better grasses. The important thing is to have a good mixture of grasses and clover that cover a wide range of soils, as far as their adaptability to soils of varying fertility is concerned. The more uneven the hill country and the more variable the farm management the greater is the need of a big range of adaptability in the mixtures of grasses that are sown.

In future articles of this series it is intended to deal with the individual species of grasses and clovers, and to endeavour with our present knowledge to indicate which species are likely to prove the best and how each will play its part in the process of winning the country now under consideration back to good grassland.

(To be continued.)

THE BUSH-SICKNESS INVESTIGATION.*

LABORATORY WORK AND RESULTS.

B. C. ASTON, F.I.C., F.N.Z.Inst., Chemist to the Department.

I. INTRODUCTION.

In the following pages it is hoped to throw some light on the obscure malnutrition trouble in domestic ruminants known as "bush sickness" by recording the results of laboratory work; but it is first desired to prepare the reader by a general statement of the case as it appears to a chemist, which will be followed by the recital of the details of laboratory experiments and end with a summary of conclusions and suggestions for future work.

It must be accepted that in the early stages of the investigation, which was begun about 1898, the veterinary pathologists fully satisfied themselves that the trouble was neither contagious nor infectious, and that no pathogenic organism could be detected or isolated, nor could the presence of any such organism be inferred by transfusion experiments of blood from unhealthy to healthy stock. Further extraordinary circumstances incidental to bush sickness ascertained were the confinement of the disease over long periods of time to one special area, where it invariably appears in all cattle and sheep if pastured long enough in that area, the rapidity with which such stock recover after removal from that area, and the absence of any acquired immunity.

From many opinions it will be sufficient here to quote Mr. H. A. Reid, Officer in Charge of the Department's Veterinary Laboratory, Wallaceville, who stated, after a long experience with bush sickness and with those veterinarians who came more immediately into contact with bush sickness in the field, "It is not a disease in the ordinary sense of the term, but a state of malnutrition resulting from some hitherto unascertained cause. All attempts to artificially infect animals with products from pre-existing cases have consequently failed, and the elucidation of the problem has resolved itself more into a question for the physiological chemist than the veterinarian." ("Diseases of Farm Animals," 1923, p. 481.) This may be taken as the official veterinarian attitude, arrived at after years of field-work and observation by a number of professional and stock officers, and it clears the ground considerably for the chemist. The latter, however, has always been handicapped by having his laboratory some four hundred miles from the bush-sick area. The difficulties introduced by this geographical limitation will become sufficiently obvious as this narrative proceeds.

DIAGNOSIS AND SYMPTOMS.

There can be no doubt that the ailment has been correctly diagnosed as progressive anæmia. Thus Dr. J. A. Gilruth reported that his observations showed there was in the later stages a very decided anæmia.

* See also "Bush-sickness Investigation: Five Years' Work at the Mamaku Demonstration Farm," in last month's *Journal*.

The symptoms of bush sickness are accurately described by Reid (*l.c.*, p. 481) as follows:—

> The symptoms of "bush sickness" in both sheep and cattle are similar. They appear within five months to a year after depasturing stock on affected country—sheep showing signs of disordered health earlier than cattle.
>
> The earliest evidence of the complaint is seen in the general aspect of the animal, its condition appearing poor in relation to the abundance of feed to which it has access. Soon afterwards a pronounced unthrifty appearance sets in. The wool of sheep becomes lustreless, dry, and harsh to the touch, while it has a tendency to loose its natural curl and to stand up like hair on the body.
>
> In cattle much the same train of symptoms takes place. The animals look "tucked up" in the flank, coat dull and staring, and a general haggard appearance takes the place of the sleek condition which the animal should possess in response to the amount of apparently good feed which is being consumed. The further stages are those of progressive loss of condition, and gradually increasing weakness. The animals are easily approached. Sheep become too weak to escape, and are readily captured. Finally the victims of this malady lie down and die of starvation amidst plenty. It is not uncommon to find young beasts, emaciated and weak, dying in a luxuriant clover-paddock.

An additional symptom not mentioned is the running at the eyes in sheep.

Post mortem examinations of animals suffering from bush sickness have been frequently made. Gilruth noted a fatty infiltration of the liver, which later and wider experience has proved to be always present in typical cases. Later Dr. C. J. Reakes, who succeeded Dr. Gilruth in the active direction of the investigation and entered into the work with painstaking care, stated that in a series of *post mortem* examinations there was, apart from the extreme emaciation characteristic of bush sickness in its last stages, only a marked fatty infiltration of the liver, and a very slight gastric catarrh and very slight catarrhal nephritis, the last mentioned being only detected on microscopic examination of tissue sections. Clotting of the blood was very rapid after it had been removed from the animal. Gastric, intestinal, and bronchial parasites were usually absent and never present in quantity. No blood parasites could be detected. Blood counts showed some diminution in the number of red corpuscles, and the hæmoglobin test demonstrated a well-marked deficiency in haemoglobin, a result which chemical analysis of the blood of diseased animals has borne out.

HYPOTHESES AS TO CAUSE.

There have been several hypotheses advanced from time to time as the cause of bush sickness: (1) A deficiency of some important constituent in the food-supply; (2) the presence of some mineral poison, or possibly some organic poison in the food-supply; (3) a want of proper balance in the food constituents; (4) a deficient or poisonous water-supply.

First of all it is desirable that the drinking-water should be eliminated as a suspected cause, and this can be done with perfect assurance. The writer is in complete accord with the statement that the water-supply has no immediate bearing on the disease. Where animals keep healthy on land containing springs, whereas on nearby land containing no springs they develop bush sickness, the true solution of the discrepancy is no doubt that the former land differs in some essential from the latter, and that the production of springs in the first case is an adventitious result due to some difference in the mode of formation of

the land or of its situation. Chemical analyses and experiments on animals reveal no reason why the composition of the natural or artificially stored waters of the country should be suspected of having the slightest influence on the incidence of the disease.

With the elimination of the drinking-water one is naturally restricted to a consideration of the food as the cause of bush sickness, and must be confined to a consideration of the first three suggested causes. As all food consumed, however, is grown on the spot it will be as well if the inquiry is first directed to a consideration of the soil which grows the food, and to this end some space will be devoted to a study of the highly abnormal kind of soil upon which the pasture is grown which produces the condition in stock without precedent in other countries.

The soil of the bush-sick area is certainly highly abnormal in origin, character, and situation. It is a soil unprecedented in its environment, and hence one may expect little help from a study of pumice soils in other countries. One would have to look for a similar soil put to similar uses in a similar climate in order to derive any assistance from the practice of other countries. So far the writer has not been able to learn of any area in any other part of the world which corresponds to the bush-sick area.

Soils are almost invariably formed by the weathering and disintegration of rock, a slow and gradual process whereby much of some of the original constituents of the rock is dissolved out and washed away in the drainage-water. The soils of this "sick" country, on the contrary, have not been weathered to the same extent. They are invariably soils consisting largely of pumice and other ejectamenta comparatively recently blown out of the bowels of the earth, and scattered by the wind over a large area of country. Pumice is an acidic lava (containing a large excess of silica or silicic acid) which has been frothed up when in the molten state, and so intimately mixed with the gases of the volcano that the apparent specific gravity of the rock is very much lessened; owing to the entangled gases the solidified pumice is enabled to float on water, or to be wafted considerable distances by air-currents. It is a well-known fact that recently ejected volcanic ash will not grow crops until the sulphides, which are poisonous to the plants, have been oxidized into harmless sulphates. It is possible that pumice will not grow animals for some similar reason.

We have thus two very distinct points of dissimilarity between bush-sick pumice soils and ordinary soils. The bush-sick soils have been deposited from air (not water), and the particles had not at the time of deposition been weathered or decomposed. There is much pumice soil which has been weathered and deposited by running or lake water, and which exists in the form of terraces. To these areas the stigma of bush sickness does not apply, and it is open for a topographical and soil survey to demonstrate that pumice soils formed in a normal manner are free from bush sickness. As an example one might instance the lands surrounding the Town of Rotorua, which are free from bush sickness although composed mainly of pumice. Most soils within this great crater, however, have been laid down by water mainly. This is shown by the terraces which exist on all sides of the lake.* This Lake of Rotorua was very much higher than it now

* Some of the higher terraces in the Rotorua crater may have been overlain by aerial deposits subsequent to the rapid lowering of the lake-level.

is—possibly some hundreds of feet above its present level. The waters no doubt subsided quickly at first, as they did at Lake Tarawera after the 1886 eruption; afterwards the sinking of the lake-level was more gradual, allowing aquatic and moisture-loving plants to grow readily and form humus as the terraces were formed, and this gradual sinking is still going on. Thus two great agencies are at work on the pumice in the Rotorua basin—compaction by pressure, and weathering by water and dissolved gases assisted by humus. These treatments are no doubt the most valuable which may be applied to the light soils of the volcanic plateau. In farming practice they are represented by rolling and by supplying humus, but all the rolling possible in farm practice will not equal the pressure which has been applied by hundreds of feet of water upon every acre.

The writer does not intend to quote figures in this introductory article, but it may be here said that the pumice soils yield only, by the ordinary laboratory methods of attack, exceptional results in the mechanical analysis designed to disclose the texture of the soil. It is found that the texture is extremely coarse—a feature which is mitigated by the abundant and well-distributed rainfall.

SOME DISCARDED HYPOTHESES.

When samples were first obtained for chemical analysis from the bush-sick area, in 1901, the outstanding chemical result shown by the cocksfoot-grass from unhealthy country was the small amount of phosphoric acid present compared with the amount found in grass growing on normal healthy country. The soils themselves did not show any great deficiency of phosphate, although they were not well supplied with this essential plant-food. The possibility of phosphate deficiency being the sole cause of bush sickness was early recognized, and thoroughly tested by top-dressing old pasture with an excessive application of superphosphate (7 cwt. per acre), and pasturing steers on the treated pasture. Although these beasts remained healthy for about twelve months after the animals on the adjoining untreated pasture had died of bush sickness, the animals on the treated pasture eventually fell sick also and had to be removed. Thus, although top-dressing grass with phosphate lengthens the time during which stock may be kept healthy from six months to two years, phosphate treatment cannot be relied upon to keep stock permanently healthy. Moreover, animals store up in various parts of the body inorganic or mineral foods which are assimilated in excess of the immediate requirements of the body. Thus iron is stored up in the liver, spleen, and bone-marrow. Phosphates are deposited in the bony tissues of the body. When the supply of any mineral food cannot be assimilated from or falls short in the food the animal may draw upon its stored up reservoir of mineral food.

In the case of phosphates being deficient in the food-supply one would expect that the bones would be the first to suffer and to show signs of weakness. The bones contain a far greater percentage of phosphate than any other part of the body. In some parts of New Zealand there develops in ruminants a bone-disease known as "Waihi disease" in cattle, and osseous cachexia and osteomalacia in sheep. This bone-disease yields at once to treatment of the pasture by top-dressing with phosphate or by drenching the animal with a medicinal

phosphate. It seems fairly well proved, then, that in such cases the animal is unable to obtain enough phosphates from the food, and that when it is supplied, either in the food or as medicine, the animal recovers. If, therefore, the deficiency of phosphate were the sole cause of bush sickness one would expect that the bones of stock dying from that disease would be unusually fragile or abnormal in external character and chemical composition. The contrary is the case. The bones have been proved to be normally strong and of the usual composition. Bone-disease in cattle has, however, recently occurred in a pumice area, and has yielded to the same treatment that would be applied if it had occurred on any other type of soil.

When unmixed with decaying vegetation or humus, pumice soils are often very low in phosphoric acid, but when a pumice soil has grown forest the action of life results in bringing phosphates to the surface—the result of the continuous fall and decay of leaves, branches, fruits, and flowers. It seems a provision of nature that life on land results in the accumulation at the earth's surface of phosphates, thereby enabling the plant and animal population to become increasingly denser. Phosphate, as is well known, cannot be washed out of the soil to any extent by the drainage-water. The hypothesis that phosphate deficiency is the single cause of bush sickness was thus early examined and discarded.

Another highly abnormal occurrence in the pumice country is the relatively large amount of silica in the dissolved solids of the surface waters, springs, and wells. Usually in natural waters silica is quite a minor constituent, but in the waters of a large area of the North Island Plateau and Upper Waikato Basin silica is the principal solid constituent. Although small in absolute amount it is relative to the other solid constituents—lime, magnesia, soda, and potash—large in amount. This abnormality was considered important enough to investigate. An experiment was therefore carried out for some time at the Wallaceville Laboratory with the object of determining whether an excess of soluble silica was injurious. The result was entirely negative — no injurious effect could be produced on a calf by prolonged feeding with a soluble silicate. This result was not unexpected. When it is considered what large amounts of silica must be ingested by the animal in the grass it eats each day it is difficult to imagine that a few more grams of silica would prove injurious.

The possibility of an excess of potash being responsible was also investigated, but no evidence could be obtained to show either that potash was present in the natural fodder in excessive amount or that, if so present, it could give rise to the symptoms characteristic of bush sickness.

Salt, which is supposed to assist the animal in the elimination of the large quantities of potash which are daily consumed by grazing-animals, is always supplied to animals on the Mamaku Demonstration Farm, and they avail themselves freely of such opportunity of obtaining it. The administration of salt as a lick is evidently beneficial to both sheep and cattle on bush-sick country, but although it may extend the time animals may be kept healthy its absence as a lick cannot be considered as a cause of bush sickness.

In the next article it is proposed to deal further with the theoretical aspects of the problem.

(To be continued.)

TICKS ON CATTLE AND OTHER STOCK.

THE NORTH AUCKLAND INVESTIGATION.

J. G. MYERS, Biological Laboratory, Wellington.

THERE have now been completed over a year's observations on the cattle-tick, *Haemaphysalis bispinosa* Neumann, in the North Auckland district. The results are embodied in a detailed and lengthy report which it is hoped will be published later. For the more immediate information of farmers the summary which forms the basis of the present article has been prepared. In this *Journal* for August, 1923, the writer presented a preliminary report on the progress of the investigation, and dealt with the main facts of life-history and host relationships so far as they had then been ascertained. Most of the matter given below is supplementary to the previous article, but where conflicting statements occur this is an indication that subsequent work has forced a revision of previous conclusions.

LIFE-HISTORY: FURTHER NOTES.

The average number of eggs laid by *H. bispinosa* is about a thousand. Compared with the performances of many exotic ticks this is quite low. Quite closely related ticks in other countries have been known to lay as many as ten thousand eggs.

When the fully engorged female drops from the host and seeks shelter on the ground, a certain period elapses before she commences to lay. This resting-time is at least a week, but it varies greatly according to the temperature. Thus in March it may be a fortnight, while in late winter to spring the female may remain nearly nine weeks before beginning to lay. Such dependence on seasonal and climatic conditions is of great importance from the viewpoint of control. It is believed that owing to the wet winter and late spring of 1923 in the North Auckland district the tick was considerably later in appearing and in reaching its maximum of abundance in the various stages than in previous years. Since the main and only large infestation by adults occurs about midsummer, at which time the hot weather reduces the pre-oviposition period to its lowest term, seven or eight days may be taken for all practical purposes as the normal time.

The male has been found, throughout the investigation, to be so excessively rare that it is extremely probable that the female ticks are parthenogenetic, or possessed of the very convenient power of laying fetile eggs without the intervention of a male. A considerable number of unfed females were collected by sweeping from the grass where they awaited hosts, and placed *in a bag* on the scrotum of a bull. No males were present on the scrotum, nor was it likely that they could enter the bag even if they were present in the vicinity. Yet of the three engorged females which were recovered in this experiment two laid fertile eggs. This, of course, is by no means a definite proof that the tick is parthenogenetic, but, taken in conjunction with the

great scarcity of males, it is held to indicate a strong probability. It is most unlikely that pairing takes place off the host. Certain ticks in other countries, of which particulars are given in the full report, have been conclusively shown to be parthenogenetic.

With regard to the hatching of the eggs, experiment shows that there is a steady advance in the time taken by the eggs to hatch as early autumn passes into winter—a long hatching-period in early spring and a much shorter one as soon as the weather becomes hot. Thus eggs laid in the middle of March remained thirteen weeks before hatching, while some deposited at the end of November produced seed-ticks in a little over five weeks. So here again is seen a very strict dependence of the life processes on seasonal conditions.

Larvæ and nymphs stay on the host about six days each, and adults about seven, under late summer conditions. All this time they suck blood. The development from larva or seed-tick to nymph or first eight-legged stage requires about three weeks, and that from nymph to adult four weeks under late summer conditions.

ETHOLOGY.

Under this title have been grouped such observations on various aspects of the habits and behaviour of the cattle-tick as could not legitimately be treated in any of the other sections. Such matters as the distance a tick crawls when it has dropped from the host, the nature of the shelter it prefers—whether moist or dry, cool or warm, light or dark—the manner in which it finds its host—are all amenable to strict scientific treatment, are all of great interest in themselves and most important, and are all of the greatest importance from the standpoint of control. The results of lengthy but perhaps not intrinsically interesting experiments are here summarized.

In *H. bispinosa* we find the extraordinary condition, by no means unique among ticks, that the creature is apparently lacking organs of sight, hearing, and taste. The general skin-surface is probably diffusely sensitive to light, but otherwise the tick, which crawls apparently at random to await a host at the top of the herbage, is completely blind. Nor has it hearing to assist it in its search. But the two legs of the first pair, which are seen to be frequently used in a feeler-like manner, possess not only probably keen sense of touch, but bear also each a tiny vesicle known as Haller's organ and functioning as the organ of smell. The tick, then, gains nearly all its knowledge of the outside world by touch and smell.

The fully engorged female is definitely negatively phototropic; in other words, it invariably seeks darkness rather than light, and freedom from the latter is therefore an essential feature of the shelter it seeks while preparing to lay its eggs.

There appears to be an optimum condition of moisture for ticks seeking shelter off the host. Under too wet conditions ticks crawl away from moisture, while in too dry surroundings they are attracted by water. In experiments arranged to show these characters it is, of course, essential to eliminate all subsidiary factors.

It is interesting to note that waiting unfed seed-ticks may be as plentiful on grass-tops at night as in the daytime.

FIG. 1. NYMPH TICKS ON HORSE'S NOSE IN VARIOUS STAGES OF ENGORGEMENT.

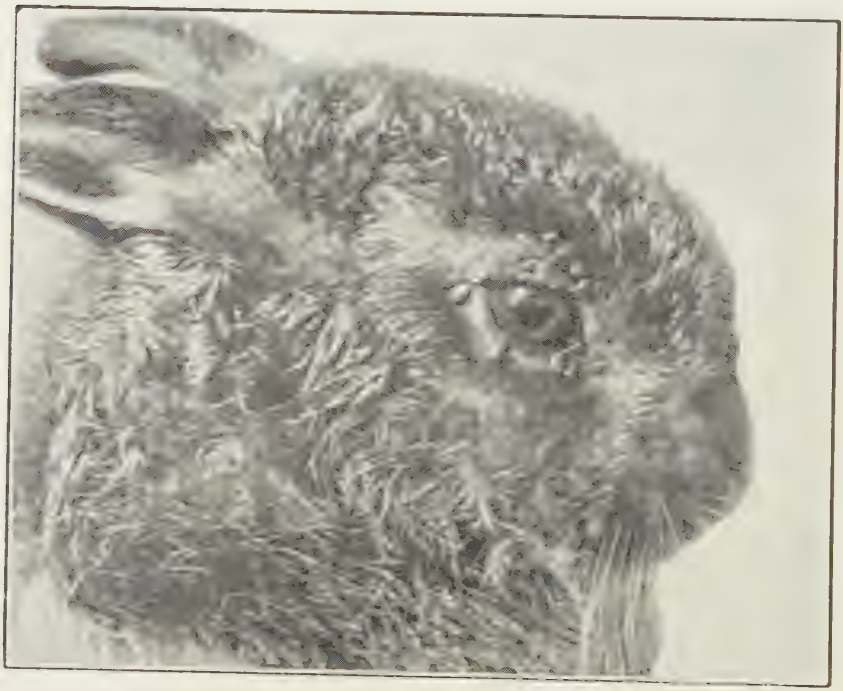

FIG. 2. VERY YOUNG HARE INFESTED WITH NYMPH TICKS.

[*Photos by the writer.*

The longest period for which this cattle-tick has survived without food (under the most favourable artificial conditions possible) is nine months. In nature such longevity would be almost impossible. As might be expected from the fact that nymphs are the wintering stage, it was ticks in this stage which made the record—a record, by the way, which has been very badly beaten by several species of exotic ticks.

SEASONAL LIFE-CYCLE.

The three main facts which emerge from a consideration of the data collected on this subject are, firstly, that in the late winter and early spring there is a heavy and practically pure infestation of nymphs; secondly, that in late summer and autumn there is an almost equally pure infestation of seed-ticks; and, thirdly, that the adult infestation is at its height at midsummer. Previous work on this subject was led astray by the occurrence of an appreciable infestation of adult ticks in August–September. These adults have now been proved to be overwintered stragglers, the progeny of which, delayed in hatching by the cold weather of early spring, go merely to swell the ranks of the one big larval infestation in late summer. For all practical purposes the course of the seasonal cycle may be described as follows: Eggs are laid by the summer adults, and these produce a large seed-tick infestation in late summer and autumn. Towards the end of this period the engorged larvæ drop from their hosts and seek shelter on the ground, where they cast their skins and emerge as unfed nymphs. These nymphs secrete themselves, preferably at the bases of the clumps of rushes or wiwi which form almost the only shelter in winter when the grass is eaten short, and remain there till July, when they swarm up the herbage and attack their hosts in such numbers as to form a heavy and very pure nymph-infestation. When these have fed to repletion they seek shelter on the ground once more in order to pass through their final metamorphosis into adult ticks. But as the weather at this season is still wet and fairly cold the process is drawn out until well into November, when the great adult infestation commences. There is thus only one brood per year.

HOST RELATIONSHIPS.

There are in the North Auckland district seventeen species of wild and domestic mammals. Of these no fewer than ten act on occasion as hosts of the cattle-tick, a role which is played also, though to a practically negligible extent, by some seven species of introduced and domestic birds.

Cattle, of course, are the chief farm-stock infested by this tick, but horses (particularly by the immature stages—*i.e.*, seed-ticks and nymphs) and hares are also heavily attacked. One very young hare, kindly brought to the writer by Mr. E. Fitzgerald in September, had no fewer than 155 nymph ticks about its head, nor was this the whole of the infestation, since some ticks escaped the counting.

It was at one time supposed that sheep were not appreciably attacked, and it was therefore not until 1923 that they were placed on the list of stock to be dipped for cattle-tick. Sheep were examined in a heavily infested tick district in Hokianga at the height of the adult

infestation. The majority were not heavily infested, though some had a fair number of unfed adults on the ears, axillary regions, and brisket. One ewe, an unshorn straggler, was considered by farmers present and by Stock Inspector C. F. Jacobs, of Kohukohu, to be as thickly infested by cattle-tick as a sheep ever is, except that in this case excessive numbers were not present on the legs. On this ewe ticks were very plentiful on the brisket, where the wool was worn short by lying down, and they had penetrated from here into the wool of the neck, which was largely filthy with tick excreta. Most of the ticks in the wool, however, were dead, particularly engorged or partly engorged ones, though dead unfed ones also were quite common. The number of live ticks *in* the wool decreased with the stage of repletion, showing that, even when they had been able to crawl into the wool, engorgement often prevented exit. No direct evidence has yet come to the writer that sheep are ever infested over the general body-surface, nor is it thought in the least probable that such will ever occur, except possibly in sheep immediately after shearing, when the wool is so short as to offer but little impediment to the tick.

It is a common occurrence for unfed stages of the tick to climb from the grass on to a person. Apparently only a small proportion of these achieve attachment, but cases are not rare of engorged adults being found attached beneath the clothes. However, none of the stages of the tick can be considered a pest of any consequence to adult human beings. But to children the larvæ and nymphs, and to a less extent the adults, are a real nuisance. Very small children become infested when playing in the long grass, and the ticks are not discovered until they have caused considerable and often serious irritation.

In view of the possibilities of extended carriage by bird hosts the study of these becomes of great importance ; but it should be stated at the outset that *H. bispinosa* seems to be pre-eminently a mammalian host tick, and its infestation of birds apparently slight and accidental. Such birds as frequent ticky paddocks can presumably hardly escape infestation, but birds are not suitable hosts, especially for the adult ticks. It is almost essential that the parasites should find a position of attachment reasonably beyond the reach of the bird's beak ; consequently the majority of ticks on bird hosts are collected about the head. The belief that kiwis and seagulls carry ticks is apparently founded entirely on confusion with the bird-ticks of the genus *Ixodes*, which superficially resemble the cattle-tick but are adapted for living entirely on birds. No cattle-ticks have ever been recorded from the birds in question, nor from any other native bird. Altogether it appears obvious from the data available as to the relation of birds to the cattle-tick that their value as tick-destroyers immeasurably counterbalances their damage as tick-carriers.

The cattle-tick seems to exhibit a strong preference for hosts (cattle) with a dry scurfy skin due to defective secretion of the sebaceous glands. Consequently susceptibility to tick-attack may in certain cases be more or less hereditary, or due to lack of condition.

NATURAL CONTROL.

Like most other organisms, the cattle-tick is prevented by natural means from increasing to an enormous extent. Of climatic factors

dry heat is probably the most severe in its effects on ticks, especially when the latter are off the host. A plant stands any amount of sun provided it is well watered, but cut leaves wilt immediately. In the same way, when engorged ticks have once dropped, a little exposure to direct sun will kill them. The eggs are similarly susceptible. Excessive moisture also appears to be inimical to the tick.

The chief natural enemies are birds, and of these the most important is the English starling. One farm was examined on which practically

FIG. 3. BADLY TICK-INFESTED PADDOCK OF PASPALUM AND RUSHES.

The rushes in the foreground are in moister ground and sheltered very few wintering nymph ticks. The rushes near the cabbage-tree are on drier ground and sheltered numerous ticks.

[*Photo by the writer.*

complete control of ticks had been effected by starlings alone. This farm has been exempted from other control-measures for a time sufficient to study exactly the good which starlings are doing.

It has been suggested that African oxpeckers be introduced, but these birds have been shown to be injurious to the cattle. Moreover, it is probable that the starlings unaided will do the work quite as well as any others that might be imported.

ARTIFICIAL CONTROL.

The most detailed knowledge of its biology is necessary for the elaboration of successful eradicatory measures against the cattle-tick. Dipping, spraying, hand-picking, and dressing are all in operation more or less extensively in the tick area, and all are doing a certain amount of good. Prolonged immersion in sea-water is strongly believed in the North to cause the dropping of ticks from the host. This has been found by direct experiments to be only partially successful, and, moreover, to be only very infrequently easily practicable.

The burning of herbage harbouring ticks, especially during late autumn and winter, is most valuable as a means of wholesale destruction, but it presents considerable difficulties, since paspalum (of which North Auckland pastures are so largely formed) remains green till autumn and is very hard to burn. A modification of farm practice in the direction of keeping the grass eaten to a turf and eliminating rushes would destroy the greater part of the shelter of ticks off the host, and would probably do more towards their final extermination than any other means at present recorded.

DISTRIBUTION.

The headquarters of *H. bispinosa* are in the Oriental region, particularly in India. The headquarters of this tick in New Zealand is the North Auckland Peninsula, which corresponds to the North

FIG. 4. SUMMER GROWTH OF PASPALUM, SHOWING SHELTER FOR UNFED TICKS WAITING FOR HOSTS.

[*Photo by E. Bruce Levy.*

Auckland botanical district, and enjoys an equable and warm climate more suitable than any other in New Zealand for a tropical tick.

This tick is apparently more subject to the influence of climatic conditions when off the host than when attached. The uniformity of climate over the area in New Zealand most heavily infested by the tick, together with the close correspondence between the greatest distance of its range north of the Equator (in Japan) and south (in New Zealand), appears to suggest that the climatic factor has been a marked feature in keeping it so far from spreading farther south in this country.

Topography affects tick-distribution only secondarily by its effect on the vegetation. For this reason, for instance, the tick population of hilly country tends to be concentrated on the valley-flats.

FIG. 5. PASPALUM AND RUSHES IN EARLY SPRING.

The grass has been eaten short, but the rushes sheltered a very heavy population of nymph ticks throughout the winter, and afforded a vantage-point from which they could climb on to cattle in spring. Had the rushes been destroyed practically no ticks could have survived the winter in this paddock.

[*Photo by the writer.*

Soil factors influence tick-distribution through their effect on the nature of the vegetation. Thus the density of the tick population on the various soil-formations of North Auckland appears to correspond very closely with the prevalence of the grass *Paspalum dilitatum* and the rush or wiwi *Juncus effusus* on these formations.

Botanical factors are shown to be very important for the life of the tick. It is perhaps no exaggeration to state that paspalum and the rush are more important in this regard than all the rest of the vegetation combined. The former supplies most of the summer shelter and vantage-ground for the unfed larvæ and adults, while the latter affords winter quarters to the nymphs, and points from which they may climb on to cattle in the spring. It is safe to say that if paspalum were kept closely grazed and rush clumps destroyed, either by drainage or direct destruction, the decrease in ticks would be enormous.

The presence of suitable hosts is, of course, necessary, although the abundance of ticks is shown to be not directly dependent on the number of the hosts. Thus there are extensive areas in North Auckland surrounded by ticky districts, receiving before the gazetting of regulations numbers of infested cattle, and supporting a heavy population of dairy cattle, and yet they are free from ticks.

HISTORY OF THE CATTLE-TICK IN NEW ZEALAND.

Of the five theories (see also *Journal*, August, 1923, p. 68) advanced to explain the introduction of the tick into New Zealand not one is based on observed fact. Perhaps the most plausible explanations are those which ascribe it to the agency of migratory birds and to imported Indian sacks and bagging-material respectively. The only scientific view must be strongly non-committal.

The first tick of which definite record is available was caught in December, 1910. There is positively no reliable evidence that the tick was in New Zealand more than three or four years previous to this date. The Whangarei (Parua Bay) and Kaitaia districts seem to have been the first centres of infestation. In 1917 the increase of the tick had become very marked. In 1919, after cattle-dips had been erected in various parts of the infested area, regulations under the Stock Act were gazetted by which three-weekly dipping of horses, cattle, and dogs throughout the season was made compulsory, and restrictions were imposed on the movement of these three classes of stock. It was found impossible to enforce three-weekly dipping, and so in 1923 this clause was revoked. At the same time sheep were added to the list of stock which must be treated for tick before leaving the area.

ACKNOWLEDGMENTS.

It would be impossible to mention personally all who gave assistance to the writer in the course of the investigation. In the field Messrs. L. Keen, D. Lewis, W. H. Maria, and B. Welsh, and the local Stock Inspectors, notably Mr. J. D. Anderson, of Kaitaia, were of special assistance. At headquarters the Director of the Fields Division (Mr. A. H. Cockayne), the Officer in Charge of the Biological Laboratory (Mr. R. Waters), and the Entomologist (Mr. D. Miller) granted every possible facility for carrying out the investigation.

Detailed studies, acknowledgments, and references will be found in the full report.

BRAN AND POLLARD.

THEIR RELATIVE COMPOSITION AND QUALITIES.

L. D. FOSTER, Analyst, Chemistry Section.

WHEN, in the process of flour-milling, the kernels of wheat are broken and gradually reduced, and flour as we know it ultimately obtained, bran and pollard are essential by-products of the many operations to which the wheat has been subjected. Because of their value and extensive uses these two feeding-stuffs are of importance not only in the economy of the farm, but also in that of the mill. There being a considerable difference in their price, it becomes a matter of interest to know what is bran and what pollard.

Every one knows the obvious differences in appearance of bran and pollard. At the same time, to say where bran ends and pollard begins may in certain cases be difficult. The exact point of separation is at present a rather arbitrary one, and one genuine pollard, owing perhaps to a rather "branny" appearance, may look somewhat different from another which is mealy, lighter in colour, and different in feel. The reasons for these differences may become clearer if a few facts concerned with milling are briefly considered.

PROCESSES OF MILLING.

The aim of the miller is to obtain a good quality of flour from the wheat which he mills. Briefly, he does this by removing as completely as possible, with due regard to the quality of product he will obtain, the inner floury portion of the grain from its outer husky covering. The miller subjects the wheat-grain to a whole series of processes by which it is broken or torn and the inner floury part gradually reduced between pairs of smooth rollers. While reducing the flour his object is to keep the branny coating of the grain as whole as possible; this is to prevent it from breaking into smaller and still smaller particles, which might become fine enough to find their way into the flour-stream and so contaminate it. The large flaky appearance of bran shows that to some extent this aim is achieved. A certain amount of disintegration is, however, unavoidable, and pollard consists of these smaller branny particles together with a varying amount of flour which is of low grade, or difficult to remove from the fine branny material to which it adheres.

Separation of these particles of all sizes is brought about by the use of many sieves of varying meshes, until finally the resulting flour is sifted through a sieve of fine silk. Those portions of the wheat-grain which do not pass through the silk form the "offals." Thus, in the first case, are produced flour and offals. There is, however, a further separation of offals into bran and pollard; and though in New Zealand we are familiar mostly with bran and pollard, pollard is occasionally separated into further subdivisions called variously shorts, sharps, coarse and fine middlings, and pollards. As a result of the foregoing processes some wheats produce a larger amount than others of low-grade flour which cannot be sold to the baker; this is then

included with the pollard. Again, some millers will not attempt to remove as much flour from the grain as others. In both cases the pollard will be more floury than otherwise, and so variations in appearance and composition are always likely to occur.

SEPARATION.

The actual point of separation of bran from pollard depends largely upon the milling practice of the individual miller. He uses a sieve of a certain mesh to separate these two products, and the size depends upon what he finds most suitable for the conditions under which he has to work. The sieve may therefore differ in different mills. It is fairly conventional milling-practice, however, to separate bran on a wire sieve (No. 16) with about sixteen meshes to the linear inch. All that material which passes through sieve No. 16 but which does not go into the flour may be called pollard (sometimes also called "offals").

NUTRIENTS IN BRAN AND POLLARD.

Bran and pollard contain valuable amounts of those substances essential to the growth and maintenance of the body and which are called nutrients. These are:—

(1.) Protein: This is a portion of the food containing nitrogen in definite amounts. It is the essential factor in the formation of flesh, muscle, bone, blood, and all those parts of the body which have strength. It is the most valuable of the nutrients, and no other is able to replace it in its work of flesh-forming and body-building. Common examples of protein are white of egg, milk casein, and wheat gluten.

(2.) Ash or mineral matter: This furnishes the mineral matter necessary for the building of bone, and consists chiefly of lime, potash, soda, and phosphorus compounds.

(3.) Fat or oil: Next to protein, fat has the highest nutritive value. It is consumed by the body, and gives out heat and energy, or the capacity to do work.

(4.) Carbohydrates: Under this heading are included starch, sugar, and similar substances. Their functions are similar to fat, but fat is considered to be, weight for weight, more than twice as valuable as carbohydrates.

(5.) Fibre: This constituent has the least value of the six, but a certain amount is necessary to furnish bulk to a feed. Its function otherwise is somewhat similar to that of the carbohydrates, but being less digestible is for that reason not so valuable. The presence in excess of fibre, owing to its lesser digestibility, may reduce the food-value of a feeding-stuff. Bran, containing more fibre than pollard, is the less digestible of the two.

(6.) Accessory food-factors, or vitamines: Finally, there are the vitamines, otherwise known as "accessory food-factors" or "growth-promoting substances." The vitamines bear a very important role in the science of nutrition, but at present little is definitely known about them except that they are essential to growth and the maintenance of life. They are usually present in sufficient quantity in most diets if a certain variety is provided. Bran and pollard contain valuable amounts of the different vitamines.

Bran contains a fairly large amount of protein, appreciable amounts of carbohydrates and fat, and a valuable amount of ash or mineral matter which is rich in phosphorus and potash.

Pollard possesses larger amounts of protein, fat, and carbohydrates, and smaller amounts of fibre and ash, than bran. Being also more digestible, it is more valuable as a feeding-stuff, and commands a higher price.

Samples of pollard vary considerably in appearance. Some have a floury appearance, due to the inclusion of a certain amount of low-grade flour; others are more like fine bran, and do not appear to have any very fine particles included with them. These latter samples are generally lower in protein and higher in fat than the floury samples, and are not quite so digestible.

AVERAGE COMPOSITION.

In 1917 T. B. Wood (*Journal of the Board of Agriculture* (England), 1917, p. 1183) gave the following average analyses of some representative English samples :—

Table 1.—Average Composition of Bran and Pollard.

——	Moisture.	Protein.	Fat.	Carbo-hydrates.	Fibre.	Ash.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Bran	13·6	13·4	3·9	53·0	10·6	5·5
Pollard	13·7	15·5	4·4	58·5	4·9	3·4

The samples analysed were normal offals. The results obtained possess a definite value, since it was found that there was practically no overlapping in the composition of the pure grades investigated. These figures apply, of course, to English samples. Commercial brans and pollards will be found to vary considerably from these averages, owing chiefly to lack of uniformity in the methods of separation. Figures obtained in other countries differ from those quoted in certain respects, Canadian figures, for instance, being for the most part higher in all constituents except carbohydrates. This result is probably due to the excellent quality of the wheats which are milled in that Dominion.

DIGESTIBILITY.

Recent research by H. E. Woodman (*Journal of Agricultural Science*, Cambridge, 1923, p. 483) emphasizes the fact that if bran and pollard are separated always according to a uniform method they yield grades which are characterized by distinctive chemical composition, both in regard to crude and to digestible constituents, and, it follows, by the possession of well-defined feeding-values. If pollard be separated, as is sometimes done, into further grades, the finer the particles of each particular grade the higher the amount of digestible constituents and the higher the feeding-value. There is, however, a corresponding marked decrease in the amount of mineral matter present. Because of this, though bran and pollard have their different uses, pollard fetches a higher price as a feeding-stuff. To ascertain if this higher-priced pollard, as sold in New Zealand, contained any appreciable amount of

bran the Board of Trade arranged recently to collect representative samples. These were submitted to the Chemistry Section of the Department of Agriculture for analysis and report.

SAMPLES TESTED BY THE CHEMISTRY SECTION.

Fourteen samples were received. One of these was a bran; the others were reputed to be genuine pollards. They were analysed for protein, fibre, and ash, as it was considered that the figures obtained for these constituents would be fair indications of any departure from the average in the samples received. The following table gives the results of the analyses:—

Table 2.—Analyses of New Zealand Samples (1923).

Laboratory No.	Sample.	Moisture.	Nitrogen.	(N. x 6·25) Protein.	Fibre.	Ash.
R 1043 ..	Bran ..	11·04	2·14	13·39	11·41	5·48
R 1032 ..	Pollard ..	11·03	2·42	15·24	3·59	3·28
R 1033 ..	,, ..	10·52	2·45	15·31	4·83	3·25
R 1035 ..	,, ..	10·67	2·46	15·40	3·57	2·97
R 1036 ..	,, ..	10·53	2·45	15·31	3·68	2·90
R 1040 ..	,, ..	10·52	2·46	15·40	5·01	3·27
R 1041 ..	,, ..	10·85	2·46	15·40	5·51	3·39
R 1042 ..	,, ..	10·60	2·48	15·49	5·82	3·49
R 1072 ..	,, ..	11·54	2·53	15·81	5·00	3·31
R 1039 ..	,, ..	10·59	2·48	15·49	5·78	3·91
R 1034 ..	,, ..	10·77	2·31	14·44	6·22	3·99
R 1037 ..	,, ..	10·50	2·35	14·70	7·55	3·97
R 1038 ..	,, ..	10·63	2·32	14·53	7·34	3·94
R 1071 ..	,, ..	11·59	2·24	14·00	5·08	3·29

It will be seen that these figures agree fairly closely with the averages obtained by Wood (Table 1). Since New Zealand wheats resemble to a certain extent those grown in England, this is to be expected.

Sample R 1043 is a genuine sample of bran. This sample is decidedly lower in protein content than pollards usually are, and much higher in fibre and ash content. This analysis is remarkably close to the average figures given by Wood.

The following samples are genuine pollards: R 1032, 1033, 1035, 1036, 1040, 1041, 1042, and 1072. They are all very alike in protein content; and though there is a fairly large difference in the fibre content, the highest amount, 5·5 per cent., is not excessive. The amount of ash is much more constant, never varying much from 3.3 per cent. It is possible that this offers a good means of judging the value of a sample.

About one sample, R 1039, it is difficult to be very definite. It contained a very good amount of protein but for an average pollard the fibre content was rather high, and the ash content decidedly high. Though not possessing an average composition, this may be a genuine pollard.

R 1034, 1037, 1038, and 1071 all contain under 15 per cent. of protein. The first three are higher than average pollards in fibre content. This may be due either to separating the bran on a coarse

sieve or to adulteration. They contain just on 4 per cent. of ash. There is no doubt that these three samples contain more of the outer branny coating of the grain than is usually the case with genuine pollards.

Among the samples, R 1071 occupies an anomalous position. It is low in protein content, but possesses for a pollard an average amount of fibre and ash. These facts are consistent with a pollard containing a certain proportion of both bran and low-grade flour. A physical examination of the sample confirmed the belief that it contained approximately 10 per cent. of fairly large bran particles, together with a certain amount of flour. The protein content of this sample is low, but its digestibility probably greater than an average pollard, and the purchaser in this case would not be prejudiced to any extent because of its branny content. However, since bran and pollard have their distinctive uses, it is desirable that the grades should be kept as pure as possible.

SUMMARY.

Bran and pollard have their separate uses, but pollard is a more valuable feeding-stuff and is more expensive.

A sample of pollard produced in one mill may differ considerably from a sample obtained in another. This is due to differences in milling-practice.

When separated by uniform methods the composition or feeding-value of bran and pollard is well defined within certain limits. Adulteration of pollard with bran, which latter is cheaper, can in these circumstances be detected by chemical analysis.

At present, where there is lack of uniformity in milling, it is difficult to say whether a pollard contaminated with what is really bran has had the latter deliberately added to it, or whether the bran has found its way into the pollard owing to the method of separation adopted by the miller.

For the protection of the farmer and the miller, and to make possible the detection of adulteration, it is desirable that methods of separation of bran from pollard in the mill should as far as possible be uniform.

Rabbit Control and Trapping.—Regulations under the Rabbit Nuisance Amendment Act, 1920, relating to the destruction of rabbits in the Moawhango Rabbit District (Wellington), have been gazetted. These provide that every owner of land who is served with a notice to destroy rabbits in terms of the Rabbit Nuisance Act, 1908, must do so either by laying poison or by the fumigation or filling-in of burrows. Where it is desired to substitute other means of destroying the pest, application for permission to do so must first be made to the Rabbit Board, whose decision is final. Further, within seven days of service of the notice, all trapping on the land must cease for a period of not less than three months. The penalty for a breach of the regulations is a fine not exceeding £10.

Autumn-sown oats, in addition to providing considerable green feeding in the early spring, when it is very valuable, generally ripen about the New Year, and may be harvested before there is any chance of Californian-thistle seed maturing.

THE RELATION OF BIRDS TO AGRICULTURE IN NEW ZEALAND.

IX. THE SEA-BIRDS.

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THE title of this, the last general article of the present series to deal with the indigenous birds, may seem at first sight devoid of agricultural interest; but two considerations will serve to justify it. Firstly, the elastic category of "sea-birds" includes many species which, though they may frequent the sea or its vicinity for some portion of their time, yet seek a large part of their food inland, even on cultivated country, thus entering into the most intimate relations with agriculture in the narrowest sense. Secondly, the writers have here, more than in any other article of the series, interpreted the term "agriculture" in the very widest sense, to include the whole of man's direct dealings with the soil on which he lives.

Because the last of the indigenous birds which we shall consider are lumped together as "sea-birds" it must not therefore be assumed that any degree of true relationship exists between the four orders into which they are divided. Even their ecological relationships—that is, those deduced from a study of habits and habitat—are only very general. Their chief common feature is a certain degree of dependence on the sea, but one or two species share scarcely even this characteristic.

THE GULLS AND TERNS.

Owing largely to the long coast-line and to the accessibility of most portions of New Zealand to the sea few birds are more familiar than the "seagulls." Two species in New Zealand are among the commonest of birds. A third, the black-billed gull (*Bruchigavia melanorhyncha* Buller), is almost solely an inland species, but is now very rare. As it has been observed feeding on moths among the tussocks it must be considered a beneficial species. The useful activities of the common gulls find outlet in two directions—firstly, the scavenging of the shore-line, and, secondly, the destruction of insect pests of the farm. The casual observer idly watching the gulls on the beach appreciates nothing of that almost ceaseless food-hunt which disposes of a whole host of otherwise offensive material, all of which finds a welcome in the omnivorous stomachs of the gulls. The concourse of these beautiful birds at the refuse-outlet of the abattoirs at Ngahauranga, where they feed possibly both on the waste and on the smaller of the fish attracted to it, is one of the sights near Wellington.

The terns, less well-known but nevertheless easily recognized by their long pointed wings and even longer forked tail, are more exclusively fish-eating than their cousins the gulls, but at least one of them, as described later, feeds to some extent on worms and grubs.

The Black-backed Gull (Larus dominicanus (Licht.)).

Every one knows the large gull, with its handsome yellow bill, black back and wings, and pure-white head, neck, and underparts; but not

all are aware that the common mottled brown and grey gull of the same size is an immature bird of the same species not yet come into possession of the adult livery of black and white. The black-backed gull nests almost all round our coasts, "on tidal drift, on edges of cliffs and promontories, on bare rock" (Guthrie Smith).

Owing to its bad reputation on the sheep-run this gull is not protected by law. It is extremely doubtful, however, whether the damage to occasional lambs and sick sheep, and the theft of toheroas and other molluscs ("shell-fish," so-called), which it breaks in a characteristic way by flying with them to a height, from which they are dropped on to either rocks or hard sand, outweigh the good services rendered by this bird in season and out of season as a peripatetic scavenger on our beaches and a destroyer of noxious insects in our fields. The writers have no definite proof that the large gull ever attacks live healthy lambs, but there can be no doubt that dead lambs and sheep, and possibly sick or isolated lambs, may have their eyes picked out by this bird. The eyes seem the first point of attack in the method of the gulls, cast-up fish on the beach being treated in a similar fashion. Doubtless much confusion, which we are not yet able to clear up, exists between the work of harrier-hawk and of black-backed gull in sheep districts. We regret to find so little definite information. Mr. E. B. Ford, however, has written from Canterbury to state his opinion that the harrier often is blamed for damage committed by the gull. He writes: "The gull is very destructive to lambs. I have seen them following a ewe and a new-born lamb round the paddock, and the ewe trying to drive them away." Buller remarks on the same subject: "It is said that on the sheep-farms they are destructive to the young lambs. This is quite possible, although I think it more likely that they confine their attention to the dead and dying; and the latter would undoubtedly be attacked by having their eyes torn out, because that is the habit of this bird."

The same authority (Buller), writing at a time when the black-backed gull was protected, draws attention in the following words to the good work which it performs: "The protection of the seagull is undoubtedly having a very good effect, and a wise protection it is, for there is not a more useful bird as a scavenger of our harbours. They have recognized this fact in San Francisco, where, I understand, the penalty by law for killing a seagull is three months' imprisonment without the option of a fine."

In an earlier work Buller mentioned the good services of this bird to agriculture: "It also frequents the pastures at a distance from the coast in quest of food, doing good service to the farmer by its large consumption of caterpillars and other insect pests . . . To the agriculturist these birds, coming in such numbers and preying upon insect life, must prove of incalculable service . . . In Napier, where the cultivated grounds were at one time infested with the introduced snail (*Helix hortensis*) this gull was found to be quite invaluable."

The black-backed gull's activities, then, may be summed up in the following terms: It is highly beneficial on two counts—firstly, as a general scavenger, especially on the coasts, and, secondly, as a destroyer of noxious insects and their grubs; while it is said to be injurious on

FIG. 1. NEST AND EGGS OF BLACK-BACKED GULL.

FIG. 2. YOUNG OF BLACK-BACKED GULL, AND EGG JUST HATCHING.

[*Photos by T. Cockcroft*

sheep-stations, although no definite proof is forthcoming that it ever kills healthy sheep or lambs. In districts where sheep-farming is not the leading industry there can be no doubt that this bird should again be placed on the protected list.

The Red-billed or Mackerel Gull (Bruchigavia novaehollandiae (Stephens)).

This beautiful bird is easily distinguished from the larger species not only by its diminutive size but also by its grey mantle, the only black on its plumage being confined to the markings of the primary wing-feathers. The immature bird resembles the parent save that the wings are marked with brown, while the plumage generally is dingy, and the legs, feet, and bill blackish, the clear red of these organs being an adult feature.

In its nesting-habits this gull is more prone to assemble in colonies than is its larger congener, while the site of the nest itself is usually in a more precipitous location.

Economically the mackerel-gull, although it feeds to a considerable extent on fish, yet strongly deserves the protection which is accorded to it by law. While perhaps less active as a scavenger than the black-backed gull it is considerably more assiduous in the pursuit of insects on cultivated and pastoral ground. Especially in the north of the North Island it frequents inland fields and pastures in flocks of almost incredible size. These are particularly noteworthy during the winter months.

Buller mentions whole acres in the Thames district covered with these small gulls, devouring crickets as fast as they could pick them up. In the opening article of this series one of the present writers described a similar occurrence on a much larger scale, when in 1848 the crops of the Mormon settlers in Utah were saved from wholesale devastation by flocks of gulls which destroyed the threatening swarms of grass-hoppers.

Flocks of mackerel-gulls feeding on pastures in North Auckland in February were observed to be chasing, with neck outstretched, flying insects which they disturbed from the grass. In another locality in North Auckland, a month later, one mackerel-gull, after feeding on pasture, was found to have devoured fourteen earthworms averaging 2½ in. in length, one pupa or chrysalis (resting-stage) of *Agrotis ypsilon* Rott. (the injurious black cutworm), and one adult moth of the same species. There is thus a possibility that the insects pursued by the gulls on the previous occasion were also moths, this species being particularly abundant in grass-paddocks.

Leach, writing of the same gull in Australia, states: "Though a dainty-looking bird, it has a bad character. It is worse than any bird of prey for stealing eggs and young birds, for let a gannet or other nesting bird but leave the nest for a moment, and gulls quickly rob it of its contents. They are scavengers, and eagerly follow a ship at lunch-time to gather the scraps." There are indications that in New Zealand also it is probably as great a pest to its fellow sea-birds, but such a habit, involving as it does no disturbance of the balance of nature, obviously influences in no degree our estimate of its economic worth. The economic value and the aesthetic charm of the mackerel-gull are alike extreme.

Before leaving the gulls we should perhaps mention the fact that these birds have been accused of spreading the cattle-tick in North Auckland. It has been elsewhere pointed out, however (this *Journal*, August, 1923), that such a belief is founded almost certainly on a confusion between the cattle-tick, which has not yet been recorded from gulls, and one of the sea-bird ticks which are well known to attack these birds.

The Terns.

The black-fronted tern (*Chlidonias albistriata* (Gray)), which is one of New Zealand's own peculiar possessions, subsists less on fish than either of the two common species—the white-fronted and the Caspian. In the South Island particularly it used to be a common sight to see large flocks of these beautiful birds following the plough, ever and anon descending to seize a worm or grub from the fresh-turned soil. Such a spectacle may even yet be seen in parts of Canterbury and Otago, but, unfortunately, the bird is far less abundant than it was in the early days of settlement. Buller writes of this species: "It also frequents the cornfields and pastures, and, by devouring caterpillars and other insect pests, proves itself a valuable friend to the agriculturist."

The Caspian tern (*Hydroprogne caspia* (Pallas)) and the white-fronted tern (*Sterna striata* (Gm.)) prey very largely on small fish, which they capture by means of a characteristic dive. We are not aware that these birds have in any part of the world been accused of any great damage to fishing interests. Their economic relationships cannot be considered very striking, but the beauty of the terns is such that the absolute protection extended to them all by law is a matter for congratulation.

THE GANNET AND THE SHAGS.

We shall dismiss the New Zealand gannet (*Sulita serrator* (Gray)) in a few words, on the same terms as the fish-eating terns. It is, of course, entirely marine, so that only sea-fish form its prey. The gannet is far more exclusively fish-eating than the shags, yet the former is protected while the latter are almost universally condemned. The reason for this anomaly is not far to seek; it is as enemies of trout that shags are persecuted. The marine fish killed by gannet, shags, and terns combined are evidently negligible in quantity. There are still "more fish in the sea than ever came out of it," and so in any consideration of the economic relations of shags we can neglect their marine fishing entirely. Moreover, any species of shag which can be proved to confine its activities entirely to salt water should therefore be added to the list of protected birds.

New Zealand possesses not only a much larger number of different species of shags than any other country in the world, but also a remarkable abundance of individuals, occurring from the waters of the ocean itself to the reaches of the smaller rivers and lagoons. There are altogether at least nine distinct species of New Zealand shags or cormorants, of which eight occur on the mainland and concern us here. Not a single one of these eight is protected. Faced with this multiplicity of totally distinct kinds, every one of which has its special haunts and its own peculiar feeding-habits and food, we plead above all for

a recognition of these differences and for an impartial examination of the various species, in order that discrimination may be exercised between those which are injurious to the trout and those which certainly are not. By such a simple scientific procedure, firstly, the sums paid annually for shags' heads may be considerably reduced; secondly, a reproach to our protection laws may be removed; and, thirdly, a number of entirely harmless and interesting species may be preserved for posterity.

Of the eight mainland shags, one, the little black shag (*Mesocarbo ater* (Lesson)) has been but infrequently recorded, and that only from North Auckland, and on that account need not concern us here. The rough-faced shag (*Hypoleucus carunculatus* (Gm.)) occurs in its typical form only in the northern portions of the South Island. It is a beautiful species by no means abundant, and it confines its activities to the sea itself. Fish form but a small proportion of its food. Steps should certainly be taken to protect this economically harmless bird.

We are left with six kinds of shags on whose head is visited most of the ill feeling with which shags as a group are regarded. Before dealing with their specific characteristics it will be advantageous to make a few general observations. Writing of shags in general, Guthrie-Smith states :—

> Except on my own lake at Tutira, I believe there is no part of New Zealand where the destruction of shags is not thought to be a righteous action. Everywhere the unfortunate birds are persecuted as the destroyers of fish, and fish they do undoubtedly take. On our rivers and fresh-water lakes they are believed to harm the imported trout, and on our seas to be a menace to the fisherman's interests, and it may indeed happen that in some districts, under certain conditions, and for a time, shags are harmful. Those, however, who have most closely observed the conduct of feeding shags believe that the captures made in waters where both trout and eels abound are generally of the latter.
>
> On the salmon-rivers of Scotland, the Dipper used to be shot down until he was proved to be not an enemy but a guardian of the salmon-ova. In Victoria, too, the destruction of shags has resulted, not in an increase, but very great decrease of fish in the Murray River, its billabongs and lakes.
>
> Anglers and fishermen, like the rest of mankind, are but too prone to rush to conclusions based on insufficient evidence, and both in Scotland and Victoria, persistent observations and experiments have shown that the birds fed chiefly on the enemies of the fishes' eggs.
>
> My local experience, too, goes to prove that the presence of shags in considerable numbers is no bar to stocking suitable water. On Tutira the trout are increasing fast, although on the lake and on the run I have allowed no shags to be molested in any way whatsoever; and it may yet prove in New Zealand that the indiscriminate slaughter of shags will turn out to be inimical to the very interests sought to be preserved.
>
> In Stewart Island saleable fish is mostly obtained in the open sea, yet the shags of every species draw their main supply of food from the inlets. At any rate, it is quite unlikely that every species of shag does equal harm, and it may well happen that some of these persecuted breeds destroy crustacea that take the eggs and fry of the blue cod and other marketable fish.

Leach, in summing up the position in Australia, states: "One thing is certain—fish were formerly much more abundant, so were cormorants." Mattingley, giving his testimony in Australia, writes: "To destroy those creatures that prey upon the enemies of the fish ova and fry is tantamount to destroying the fish themselves, and in the destruction of the cormorants this procedure is exemplified."

Coming back now to those six species of mainland shags which are sufficiently abundant to need economic investigation, we find that

the following kinds are too exclusively marine to be accused of attacking trout: The Stewart Island shag (*Hypoleucus campbelli stewarti* (Grant)), the bronze or pink-footed shag (*H. chalconotus* (Gray)), and the spotted shag (*Stictocarbo punctatus* (Spar.)). Concerning the last one Mr. R. A. Falla, on whose wide knowledge of sea-birds we are again drawing, writes: "This beautiful endemic species differs in several respects from the other New Zealand shags. Particularly noticeable is its weak flight, accompanied by short rapid wing-beats. As a matter of fact these birds spend the greater part of their lives on or near the rock ledge on which they were born." Speaking of their nesting-sites he states: "The headlands and cliffs occupied are situated (in two cases) in the open sea, with 16 to 20 fathoms of water at the base This enables the shag to obtain his chief food—minute free-swimming crustaceans—within a few yards of the nest. These are easily obtained and quickly digested, and are supplied to the young by regurgitation. Pasty masses of semi-digested food can often be seen beside the nests, varying in colour from red to brown and grey, evidently different species of crustacea. A young spotted shag from the West Coast was found to contain large masses of the small red shrimp-like creature known as "whale-feed" (*Munida gregaria*)." Mr. Falla further points out that "available evidence seems to show that our oceanic shags, while structurally adapted for capturing any free-swimming creature, prefer those most easily obtained and digested."

The pied shag (*Hypoleucus varius* (Gm.)) must also be regarded almost solely as a marine species. Mr. Falla informs us that although it is found in tidal streams occasionally he has never seen it on inland waterways. Probably any report of this species inland is based on confusion with the similarly coloured though smaller white-throated shag.

We arrive then at this conclusion: that the only two shags which can possibly be enemies of the slightest importance to trout are the white-throated shag (*Microcarbo brevirostris* (Gould)) and the black shag (*Phalacrocorax carbo* (Linn.)), both of which seek a considerable portion of their food in fresh water. We cannot too strongly emphasize the fact that if any shags at all are to be outlawed it should be these two only. Having arrived at this conclusion, we must now examine the evidence for and against shags as enemies of trout. Although both the last-mentioned species are implicated, the black shag, by reason of its superior size and greater abundance, is probably the one most frequently concerned. With regard to the white-throated species Mr. Falla writes: "I have examined the stomach-contents of only one of these birds . . . It contained three eels about 6 in. long and a small fresh-water crayfish." Buller found the "stomach filled with fresh-water shrimps." The white-throated shag is particularly plentiful in the streams of the North Auckland district, where trout are in most cases not present. There eels and crayfish must certainly form the major part of its food.

The black shag, since on it is concentrated most of the warfare against shags, needs special consideration from an economic viewpoint. In this connection the evidence of Mr. Edgar Stead, as that of an angler of lifelong experience, must be especially emphasized. Speaking solely of the black shag, he states:—

And while I would be the last person to deny that the shag does take trout, I am thoroughly convinced that he deserves much more consideration from anglers than he usually receives. The chief point to which I would call attention is the indiscriminate slaughter of the shags caused by the price that is put on their heads. On this account birds are killed which have been bred on the sea-coast, have lived in salt waters or estuaries, and have probably never even seen a small trout in all their lives.

In many waters where there are both eels and trout the shags do a great deal of good by their attacks upon the former. Some years ago I shot nineteen shags on the Lower Selwyn, and cut them open to see what each of them had in its stomach. Seventeen had eels, one had some small fresh-water crayfish, and one had a small trout about 7 in. long. Therefore, regarding even the bird that was eating crayfish as doing damage by taking trout-food, the amount of good done by the seventeen is out of all proportion to the damage done by the two. I do not think that the harm an eel does to trout is generally recognized. Being largely a bottom-feeding fish, it is an especial menace during the spawning season. A 2 lb. eel could easily eat all the spawn of a 5 lb. trout, and is just the right fish to find it . . . But the damage done by eels in trout-streams is not confined to their depredations among the trout themselves. Owing to their large appetites they eat enormous numbers of small fish that would otherwise serve as food for the trout. This effect of the presence of eels may be likened to that of rabbits in sheep-country.

The reasons for a shag's preference for eels are many. Weight for weight, an eel is more nourishing than a trout. But a shag can with ease swallow a 1½ lb. eel, while it can only manage a 1 lb. trout with difficulty. The bird's method with an eel is to swallow it head first, getting about 4 in. of the fish into its stomach, the remainder being in its neck, fly to some convenient perch, and there sit throughout the process of digesting, letting the eel slide down gradually as it is digested. . . .

The young do not, unless disturbed, leave the nest until they are well able to fly, which is about six weeks after they are hatched. During this period they are fed by regurgitation by both parents. At first this requires no especial effort, the old birds delivering a small quantity of wholly digested food to the young. Gradually, however, as the offspring grow and their appetites increase, the old birds present their food in a less and less digested condition, at the last giving it up quite whole. Here is where the eel is most appreciated over the trout as a form of diet, the greater quantity which can be carried at a time and the marvellous ease with which it can be disgorged making it practically the staple nourishment of the young shags in districts where it can be easily obtained. . . . The old birds always swallow their prey head first. Thus a fish which is too long to be turned inside the bird has to be taken by the young bird tail first and swallowed that way. In the case of an eel this would make little or no difference, but with a trout it would, more especially if the parent, as it naturally desires to do, brings large fish to the nest. The result is that the fish, jamming in the young bird's throat, is rejected.

I may be wrong, but it seems to me there are many more eels at the mouth of the Selwyn now than there were ten years ago, when I first fished there. At the same time there are unquestionably fewer shags. In the shallows at the north-east corner of the lake, where I was shooting for some seasons, there were noticeably fewer eels than round the mouth of the Selwyn, and this I attribute largely to the presence of a flock of about fifty shags which fished there. . . .

And now I come to the actual taking of trout by shags. As I have already said, in districts where there are eels the number of trout taken is smaller than is usually imagined; and there are very few streams in the South Island where eels are not plentiful . . . At the same time there are, I believe, many streams in the North Island which are almost if not entirely devoid of eels. Yet even there I claim that the shag is not an unmitigated evil.

Most persons, will, I think, agree with me that the danger with many of our streams and rivers is not of their depletion of trout but of overstocking. Most of us also are well aware of the degeneration that takes place in any race that has no natural enemies—where, that is to say, there is no agent that will bring about the survival of the fittest. In the case of trout an eel can be of little use as such an agent, since by eating the ova it destroys the trout before the latter has had an opportunity of showing its fitness or otherwise. A shag, on the

other hand, taking trout of anything from 4 in. to 5 in. long, is almost certain to get the weaker members of a shoal of trout first, the stronger escaping by their superior agility and swimming-powers. I suppose that of the trout in the Avon 10 per cent. are miserable, long, thin kelts, weighing anything up to 1½ lb. I think you would have great difficulty in finding any such percentage in a stream, where there are shags fishing, and it is my opinion that a few shags fishing in the Avon would soon reduce this percentage there.

I have heard [1908] that there is a marked deterioration both in size and condition of the fish in Lake Rotorua, which is generally ascribed to overstocking. The great danger that then exists is that some diseases will break out and entirely deplete our overstocked streams and lakes, but to ensure that none but healthy fish will reach maturity a colony of shags is exactly what is required.

Buller is the only ornithologist we have read who was wholeheartedly against the black shag. He writes: "This is, I think, the only native bird to which protection ought not to be extended."

Mr. J. R. Annabell, a most careful observer, writes: "Most suitable streams are now stocked with trout, and I am of opinion that the shag is of benefit to the trout . . . He certainly helps to keep the eels in control, and one large eel can eat as many young trout as a shag."

To sum up the shag position, of the eight species of shags occurring on the mainland two are too rare to need economic consideration; four are almost exclusively coastal shags, feeding by no means entirely on fish, and even then doing no appreciable damage to fishing-interests; and, finally, only two fish to any extent in fresh water, and of these only one has ever been proved to catch trout. Regarding this last one, the black shag, it is still by no means certain that it is not more of a friend of the angler than a foe. Its persecution should not be subsidized, but whether it should be positively protected, as should be indubitably all the other species, is another matter, to be decided by impartial scientific investigation.

THE PETRELS.

New Zealand possesses no fewer than forty-one species of petrels, ranging in size from the diminutive storm-petrels to the enormous albatross so well known to ocean voyagers.

The most direct claim of the petrels to economic consideration is a gastronomic one—the young birds are still used very extensively as food, particularly by the Maori people. The taste for this food, however, is not peculiar to New Zealand. Thus Leach, writing in Australia, states: "The remarkable colony of people living on Cape Barren Island is entirely dependent on the the annual mutton-bird harvest. They claim to take about a million and a half birds each year. The number is probably much exaggerated, for Littler, in his valuable "Birds of Tasmania," gives the number as 555,000 for 1909, valued at about £4,000 . . . Flinders calculated that one flock of these birds he met in Bass Strait contained 132,000,000 birds."

The writers are deeply indebted to Mr. R. A. Falla, who is recognized as the New Zealand authority on petrels, for the following comprehensive account of the species which are actually taken for food:—

1. *Neonectris griseus* (Gm.) (sooty shearwater): This is the common commercial mutton-bird, and is the one taken in such immense numbers from Stewart Island and islets in Foveaux Strait. The usual practice is to collect

the young birds just before they leave the nest about March of each year. Occasionally a few adult birds are taken and potted in the same way at odd times during the breeding-season (November to March).

2. *Neonectris tenuirostris* (Temm. and Laug.) (short-tailed shearwater): This bird, which is the commercial mutton-bird of Tasmania and Bass Strait, seems to occur only as a straggler in New Zealand waters, and, as far as our information goes at present, does not breed here.

3. *Puffinus assimilis* Gould (allied shearwater): According to Reischek the young of this species were at one time collected by the Maoris on the Chicken Islands in February. These islands are not now visited, and the bird is not found in any numbers elsewhere.

4. *Puffinus gavia* (Forster), *Reinholdia reinholdi* (Mathews), (Forster's shearwater): This species breeds in large crowded colonies on several islands in Hauraki Gulf and off the northern coast. They are still subjected to occasional raids by the natives, March being the favourite month, when the young are just ready to fly.

5. *Hemipuffinus carneipes* (Gould) (fleshy-footed shearwater): This bird is slightly larger than the sooty shearwater, and is probably the commonest mutton-bird of the Northern coast natives. It breeds on most of the islands from the Bay of Plenty northward. A Press notice of 3rd January, 1920, reporting the capture of two thousand mutton-birds on Plate Island, probably referred to this species. These must have been adult birds, as the egg does not usually hatch until the first or second week in January. Although the present-day Maori hunts less frequently he probably does more harm than his ancestors, who observed regular seasons and never wilfully damaged a nesting-burrow.

6. *Procellaria parkinsoni* (Gray) (black petrel): Hauturu, or Little Barrier, was at one time regularly visited by Maoris in search of the young of the black petrel. Probably a few are still taken from breeding-places in the Bay of Plenty. The bird is a late breeder, the full-grown young being found in May.

7. *Pterodroma macroptera* (Smith) (grey-faced petrel): Small colonies of this species occur commonly in the northern part of New Zealand. On both east and west coasts the young bird is still taken by the natives for food.

8. *Pterodroma inexpectata* (Forster) (mottled petrel): With the following species, the adult of this petrel was once taken in large numbers by the natives during its flights to inland breeding-grounds.

9. *Cookilaria cookii* (Gray) (Cook petrel): The common practice in capturing this and the last species was to light fires and spread nets on some hilltop directly in the birds' line of flight. Urewera natives inform me that this method is now seldom practised, but that young birds of either Cook's or the mottled petrel are sometimes obtained from burrows in the inland ranges.

10. *Pachyptila vittata* (Gm.) (broad-billed prion): According to Mr. R. S. Sutherland, the young of the broad-billed prion are sometimes taken by the Stewart Island mutton-birders along with those of the sooty shearwater or common mutton-bird.

11. *Thalassarche melanophris* (Temm. and Laug.) (black-browed mollymawk): Until quite recent years the natives of the Chatham Islands regularly collected the young of this albatross for food, and no doubt they are still taken occasionally.

Several of the species breeding on the outlying islands are used by visiting parties such as sealers, or temporary settlers—*e.g.*, *Pterodroma neglecta* (Schlegel)—on the Kermadec Islands.

Finally, Mr. H. Guthrie-Smith informs the writers that in addition to certain of the above species the diving-petrel or kuaka (*Pelecanoides urinatrix* (Gm.)) is taken by the Stewart Island mutton-birders. He believes also that two other species of uncertain identity are collected in the trade.

It should be emphasized that such indiscriminate collecting is strictly illegal. The only New Zealand petrel which is not specifically protected under the Animals Protection and Game Act, 1921, is the true mutton-bird (*Neonectris griseus*), and it is to this species, therefore, that all legitimate mutton-birding must be restricted.

THE PENGUINS.

Those highly interesting birds the penguins, with their amazing adaptations to an aquatic existence, are particularly well represented in the New Zealand region, from which nine distinct species are recorded. Only one of these, the blue penguin (*Eudyptula minor* (Forster)) is plentiful on the mainland, while none are important economically. The diet consists largely of fish and cuttle-fish.

This concludes our account of the economic relations of New Zealand indigenous birds, with the single exception of the kea. A special article on this interesting bird is in preparation as the next contribution to the series.

REFERENCES.

The usual reference works of Buller, Guthrie-Smith, and Leach have been listed several times in previous articles of this series. Their repetition would serve no useful purpose. Others are as follows:—

Mattingley, A. H. E. (1908): Cormorants in Relation to Fishes. *Emu*, vol. 8, pp. 18–23.

Reischek, A. (1886): Observations on *Puffinus assimilis* (Gould). *Trans. N.Z. Inst.*, vol. 18, pp. 95–96.

Stead, Edgar F. (1908): The Black Cormorant in New Zealand. *Emu*, vol. 8, pp. 71–76.

Note.—Mr. R. H. Stidolph's name was inadvertently omitted as the photographer of Fig. 2 in the last preceding article of this series. The writers are indebted to Mr. Stidolph for his kind permission to use this photograph.

CALCIUM CYANIDE FOR RABBIT-FUMIGATION.

In the course of the past nine months the Live-stock Division of the Department has carried out a number of trials with calcium cyanide (in the powder form) as a fumigant for rabbit-destruction. The tests so far indicate that this material, while very effective and rapid in its action once the gas given off by it comes into contact with the rabbits, is slower and more laborious to apply than carbon bisulphide. The latter fumigant, which has been in very effective and satisfactory use by New Zealand farmers for a number of years, possesses the advantage that a small quantity can be applied to a rag and left to do its work in a warren, whereas a mechanical blower is required for the use of calcium-cyanide powder. The flake form of calcium cyanide, which is claimed to do its work automatically, has not yet been thoroughly tested by the Department.

The tests with calcium-cyanide powder were mainly carried out —under both dry and damp conditions of soil—in light country in the Waikato district, where rabbits burrow deep, and thorough work and efficiency of any fumigant is required to reach the lower levels of the warrens.

It may be added that the attitude of the Department towards the use of calcium cyanide is entirely open-minded. It appreciates the use of any effective agent in rabbit-control, and recognizes that different fumigants may all have their own advantages under varying conditions. Successful work with calcium cyanide has been recorded from Australia.

INTRODUCTION OF CLOVER INTO PASTURES BY SURFACE-SOWING.

J. W. DEEM, Supervisor, Moumahaki Experimental Farm.

A PASTURE, to give the best results either for fattening or butterfat-production, must have in addition to suitable grasses a good mixture of clovers. It frequently happens that after a paddock has been down a few years the clovers run out and the amount present is very small, with a consequent reduction in the feeding-value of the pasture. It is also well known that clovers exert a good influence on the grasses, which always do better if there is a fair amount of clover present.

GROWTH OF SURFACE-SOWN CLOVER AT MOUMAHAKI EXPERIMENTAL FARM.

A good demonstration of these facts was recently afforded at Moumahaki, where we had a well-sheltered paddock carrying a good sole of cocksfoot, rye-grass, crested dogstail, and Poa trivialis, but very poor in clovers. It was noticed that every time the dairy herd was put in this field the cows did not settle and went down in their milk-yield. It was not convenient nor desirable, for several reasons, to break up the field, and it was decided to try and introduce clover by surface sowing. On 1st September last a mob of three hundred ewes was put in the field, which contained 17 acres. On the 5th 2 lb. each per acre of cow-grass and white clover were broadcast. The sheep were left for another two days, when they were removed. The field

was then rolled and shut up for about three weeks. The clover germinated and grew well, with the result that the pasture is now a splendid mixture and relished by the dairy herd. The accompanying photograph gives a good idea of the growth of clover.

This demonstration is in keeping with other tests in the same district. There is no doubt that where the clover content has become small and the other grasses are still vigorous it will pay to surface-sow a few pounds of clover in the spring.

IMPORTATION OF FERTILIZERS IN 1923–24.

ANNUAL STATISTICS AND NOTES.

B. C. ASTON, F.I.C., F.N.Z.Inst., Chemist to the Department.

STATISTICS of artificial fertilizers imported into New Zealand during the year ended 31st March, 1924, are now (by courtesy of the Comptroller of Customs) available for study.

The phosphate importations are the principal feature of all fertilizer work in New Zealand. The consumption of phosphates may be considered a rough index of the amount of cropping and other intensive agriculture which is from time to time taking place. Judged from this viewpoint, the figures for phosphates covering the period under notice must be considered extremely satisfactory, as the weight of crude phosphate rock imported to be manufactured into finished fertilizer constitutes a record.

It is to be hoped that all rock phosphate which is not manufactured into superphosphate in the Dominion will be ground to the greatest degree of fineness possible. Finely ground rock phosphate is an excellent fertilizer, but when it is ground coarsely and applied to the soil the coarse particles are not available as plant-food. Further, as phosphates usually become less available in the soil, the distribution of coarsely ground phosphate-rock must lead to an economic loss, which may represent in the aggregate a very large sum. If the proportion of coarse particles is 10 per cent. it is a figure considerable enough, but when it amounts to, say, 30 per cent. a much larger amount of phosphate must be wasted. Ground phosphate rock for application to the soil as such should be ground to the same fineness as basic slag. The Department of Agriculture will test free of charge any phosphate-rock which a farmer thinks is too coarse, and, if evidence is obtained to confirm such suspicions, will have an official sample taken free of charge to the farmer, and will inform him of the result of the test of the official sample.

The importation of basic slag has increased to double that of the previous year, most of the material coming from Belgium. Another favourite fertilizer on the list, which no doubt owes much of its success to its fineness, is Egyptian phosphate (or "Ephos"). This substance appeared on the New Zealand market after a lapse of two years during

which none was imported. The figures for bonedust are double those of the previous year, but the amount imported is comparatively small. A small amount (only 255 tons) of superphosphate was imported, and it does not appear why even this was necessary, seeing that all the requirements of this fertilizer can be readily manufactured in New Zealand.

The other items given in the accompanying tables call for no special comment this year.

SUMMARY OF FERTILIZER IMPORTATIONS, 1923–24 AND 1922–23.

Fertilizer.	Quantity.		Declared Value.	
	Year 1923–24.	Year 1922–23.	Year 1923–24.	Year 1922–23.
	Tons.	Tons.	£	£
Bonedust	4,158	2,446	39,541	24,205
Bone-char	50	215	447	1,797
Basic slag	39,632	19,641	124,565	82,732
Superphosphate	255	..	985	..
Rock phosphate (raw) and guano	76,517	69,591	108,119	124,672
Egyptian basic phosphate ..	5,996	..	18,138	..
Kainit	3,975	3,894	9,557	10,481
Muriate of potash	..	60	..	627
Sulphate of potash	863	592	9,241	6,868
Potash, other	290	670	1,314	3,270
Gypsum	1,979	1,493	2,583	2,398
Sulphate of ammonia	842	436	5,439	7,420
Nitrate of soda	748	386	9,646	5,426
Sulphate of iron	63	53	549	606
Fertilizers unspecified	15	6	265	286
Totals	135,383	99,483	330,389	270,788

NOTE.—With regard to the "declared values" given above, the Comptroller of Customs supplies the following explanation: "The value for duty is defined as the fair market value in the country whence the goods are imported, plus 10 per cent. As the addition of 10 per cent. does not cover the present freight, insurance, and other charges, the statistical value is less than the actual landed value."

IMPORTS OF THE PRINCIPAL PHOSPHATIC FERTILIZERS FROM 1914 TO 1924.

Year ended 31st March.	Bonedust.	Basic Slag.	Superphosphate.	Raw Rock Phosphate and Guano.	Egyptian Basic Phosphate.
	Tons.	Tons.	Tons.	Tons.	Tons.
1914	6,578	30,350	41,582	22,093	Nil
1915	7,966	29,385	54,190	23,983	,,
1916	10,059	10,339	58,013	39,366	2,026
1917	10,386	6,660	31,962	24,993	8,614
1918	6,363	10	37,157	37,037	11,225
1919	3,468	Nil	21,400	31,351	Nil.
1920	6,272	2,759	15,842	38,861	15,000
1921	4,440	10,823	40,731	70,208	10,810
1922	4,063	13,488	3,140	45,956	Nil.
1923	2,446	19,641	Nil	69,591	,,
1924	4,158	39,632	255	76,517	5,996

IMPORTATION (IN TONS) OF PRINCIPAL ARTIFICIAL FERTILIZERS FOR YEAR ENDED 31ST MARCH, 1924, SHOWING COUNTRIES OF DEPARTURE AND NEW ZEALAND PORTS OF ENTRY.

New Zealand Port of Entry.	Australia.			Chile.	India.	United States of America.	Pacific and Indian Ocean Islands.		United Kingdom.			Belgium.		France.		Germany.	Luxemburg.	Egypt.	Netherlands.
	Nitrogenous Manures.	Bonedust.	Gypsum.	Nitrate of Soda.	Bonedust.	Basic Slag.	Name of Island.	Rock Phosphate.	Nitrogenous Manures.	Basic Slag.	Potash.	Basic Slag.	Potash.	Basic Slag.	Potash.	Potash.	Basic Slag.	Phosphate.	Basic Slag.
Auckland ..	189	2,758	1,965	75	835	500	Nauru ..	18,042											
							Ocean ..	14,000	155	5,590	205	15,423	..	..	692	1,673	600	1,000	..
							Makatea ..	17,829											
Kaipara ..	..	100	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
New Plymouth ..	..	355	..	..	..	500	..	..	..	7,450	25	5,019	25	..	48	495	..	..	..
Patea ..	..	..	..	..	..	..	..	..	..	30	..	..	..	..	..	..	..	..	..
Wanganui ..	..	..	..	..	..	..	New Caledonia	808	..	50	..	..	..	..	..	..	..	..	..
Napier ..	..	..	..	..	..	..	..	..	..	750	30	..	..	25	..	5	..	..	..
Wellington ..	90	..	..	490	..	..	..	..	20	1,338	160	1,662	20	..	255	115	..	3,150	10
Nelson ..	5	..	..	..	..	..	..	..	..	200	..	30	..	..	10	20	..	..	..
							New Caledonia	1,395											
Lyttelton ..	51	..	..	..	..	..	Nauru ..	10,074	171	25	100	50	..	..	200	100	..	650	..
							Makatea ..	3,067											
Timaru ..	..	..	2	..	..	..	New Caledonia	328	..	..	5	..	..	..	80	..	..	..	..
							Nauru ..	3,629											
Dunedin ..	16	70	11	25	..	..	New Caledonia	1,610	50	65	24	25	..	..	65	300	..	1,100	..
							Makatea ..	3,143											
Invercargill ..	35	40	..	..	..	..	New Caledonia	1,548	50	174	25	125	..	..	136	150	..	..	..

NOTE.—For the previous year's corresponding table see *Journal* of May, 1923.

GOATS AND BLACKBERRY IN PELORUS VALLEY.

A LETTER was received recently by the Department from Mr. A. J. Rush, of Canvastown, Pelorus Valley, Marlborough, intimating that he was successfully controlling the blackberry pest on his farm with goats, and could show paddocks practically clean, and others on which the goats were working or had just been fenced. Mr. Rush's farm has an area of 700 acres, and he keeps 300 goats, both pure and half-bred Angoras. The farm was visited last month by the district Inspector of Stock, Mr. J. G. Scott (Blenheim), who made the following report on the matter in question :—

"Judging from the present condition of this property, and taking into consideration the fact that until goats were used for the purpose of control all the flat and most of the easy country there was completely in possession of blackberry, it cannot be said that Mr. Rush has overstated the case where he says in his letter, 'I have done and am still doing good work with goats.' The position here as regards blackberry cannot be shown better than by simply stating the fact that for the past ten years no cutting or clearing—except in the home paddock, where the goats are too timid to feed—has been carried out, and yet the pest is well under control. As a proof of the latter fact, Mr. Rush is carrying equal to 800 sheep on about 500 acres of pasturage. This is a much higher rate than the average carrying-capacity of the same class of land.

"The use of goats, therefore, has released the owner from carrying out the almost continuous work of clearing, which before the present means was employed was found necessary. To many owners of blackberry-infested country this statement may bear the appearance of being too good to be true. But it must always be borne in mind that results such as Mr. Rush has achieved can be effected only by the use of sound methods, and by good judgment in the management of goats through the maintenance in health of these animals and their proper distribution over the various blocks on the farm; and, last, but not least, by the maintenance of all fences in a goat-proof condition.

"That goats can be successfully used against blackberry and to the extent of completely obviating the necessity of cutting and clearing it in the ordinary way is no new discovery. By the use of these animals many landowners in the Pelorus have been enabled to keep blackberry under control. Where, however, sufficient judgment and care are not exercised it would be idle for such owners to expect any great measure of success. In their cases the old methods of cutting and clearing will continue to be necessary.

"Mr. Rush strongly holds the opinion that all crossbred goats should receive the same measure of protection as is now accorded to Angoras."

Noxious Weeds.—The Mauriceville County Council has declared gorse and pennyroyal to be noxious weeds within that county. Californian thistle has been declared by the Maniototo and the Vincent County Councils and the Otago Heads Road Board not to be a noxious weed within their respective territories; ragwort has been similarly dealt with by Vincent County.

A READY-RECKONER FOR WEIGHT OF FIELD CROPS PER ACRE.

(Concluded.)

TABLE SHOWING WEIGHT OF CROP PER ACRE WHEN THE AREA FROM WHICH THE PRODUCE IS TAKEN IS 1 CHAIN IN 28 IN. DRILLS—EQUIVALENT TO $\frac{1}{283}$ ACRE.

Weight per Area.	Weight per Acre.				Weight per Area.	Weight per Acre.				Weight per Area.	Weight per Acre.				Weight per Area.	Weight per Acre.			
lb.	Tons	cwt.	qr.	lb.	lb.	Tons	cwt.	qr.	lb.	lb.	Tons	cwt.	qr.	lb.	lb.	Tons	cwt.	qr.	lb.
1	0	2	2	3	61	7	14	0	15	121	15	5	2	27	181	22	17	1	11
2	0	5	0	6	62	7	16	2	18	122	15	8	1	2	182	22	19	3	14
3	0	7	2	9	63	7	19	0	21	123	15	10	3	5	183	23	2	1	17
4	0	10	0	12	64	8	1	2	24	124	15	13	1	8	184	23	4	3	20
5	0	12	2	15	65	8	4	0	27	125	15	15	3	11	185	23	7	1	23
6	0	15	0	18	66	8	6	3	2	126	15	18	1	14	186	23	9	3	26
7	0	17	2	21	67	8	9	1	5	127	16	0	3	17	187	23	12	2	1
8	1	0	0	24	68	8	11	3	8	128	16	3	1	20	188	23	15	0	4
9	1	2	2	27	69	8	14	1	11	129	16	5	3	23	189	23	17	2	7
10	1	5	1	2	70	8	16	3	14	130	16	8	1	26	190	24	0	0	10
11	1	7	3	5	71	8	19	1	17	131	16	11	0	1	191	24	2	2	13
12	1	10	1	8	72	9	1	3	20	132	16	13	2	4	192	24	5	0	16
13	1	12	3	11	73	9	4	1	23	133	16	16	0	7	193	24	7	2	19
14	1	15	1	14	74	9	6	3	26	134	16	18	2	10	194	24	10	0	22
15	1	17	3	17	75	9	9	2	1	135	17	1	0	13	195	24	12	2	25
16	2	0	1	20	76	9	12	0	4	136	17	3	2	16	196	24	15	1	0
17	2	2	3	23	77	9	14	2	7	137	17	6	0	19	197	24	17	3	3
18	2	5	1	26	78	9	17	0	10	138	17	8	2	22	198	25	0	1	6
19	2	8	0	1	79	9	19	2	13	139	17	11	0	25	199	25	2	3	9
20	2	10	2	4	80	10	2	0	16	140	17	13	3	0	200	25	5	1	12
21	2	13	0	7	81	10	4	2	19	141	17	16	1	3	201	25	7	3	15
22	2	15	2	10	82	10	7	0	2	142	17	18	3	6	202	25	10	1	18
23	2	18	0	13	83	10	9	2	25	143	18	1	1	9	203	25	12	3	21
24	3	0	2	16	84	10	12	1	0	144	18	3	3	12	204	25	15	2	24
25	3	3	0	19	85	10	14	3	3	145	18	6	1	15	205	25	17	3	27
26	3	5	2	22	86	10	17	1	6	146	18	8	3	18	206	26	0	2	2
27	3	8	0	25	87	10	19	3	9	147	18	11	1	21	207	26	3	0	5
28	3	10	3	0	88	11	2	1	12	148	18	13	3	24	208	26	5	2	8
29	3	13	1	3	89	11	4	3	15	149	18	16	1	27	209	26	8	0	11
30	3	15	3	6	90	11	7	1	18	150	18	19	0	2	210	26	10	2	14
31	3	18	1	9	91	11	9	3	21	151	19	1	2	5	211	26	13	0	17
32	4	0	3	12	92	11	12	1	24	152	19	4	0	8	212	26	15	2	20
33	4	3	1	15	93	11	14	3	27	153	19	6	2	11	213	26	18	0	23
34	4	5	3	18	94	11	17	2	2	154	19	9	0	14	214	27	0	2	26
35	4	8	1	21	95	12	0	0	5	155	19	11	2	17	215	27	3	1	1
36	4	10	3	24	96	12	2	2	8	156	19	14	0	0	216	27	5	3	4
37	4	13	1	27	97	12	5	0	11	157	19	16	2	23	217	27	8	1	7
38	4	16	0	2	98	12	7	2	14	158	19	19	0	26	218	27	10	3	10
39	4	18	2	5	99	12	10	0	17	159	20	1	3	1	219	27	13	1	13
40	5	1	0	8	100	12	12	2	20	160	20	4	1	4	220	27	15	3	16
41	5	3	2	11	101	12	15	0	23	161	20	6	3	7	221	27	18	1	19
42	5	6	0	14	102	12	17	2	26	162	20	9	1	10	222	28	0	3	22
43	5	8	2	17	103	13	0	1	1	163	20	11	3	13	223	28	3	1	25
44	5	11	0	20	104	13	2	3	4	164	20	14	1	16	224	28	6	0	0
45	5	13	2	23	105	13	5	1	7	165	20	16	3	19	225	28	8	2	3
46	5	16	0	26	106	13	7	3	10	166	20	19	1	22	226	28	11	0	6
47	5	18	3	1	107	13	10	1	13	167	21	1	3	25	227	28	13	2	9
48	6	1	1	4	108	13	12	3	16	168	21	4	2	0	228	28	16	0	12
49	6	3	3	7	109	13	15	1	19	169	21	7	0	3	229	28	18	2	15
50	6	6	1	10	110	13	17	3	22	170	21	9	2	6	230	29	1	0	18
51	6	8	3	13	111	14	0	1	25	171	21	12	0	9	231	29	3	2	21
52	6	11	1	16	112	14	3	0	0	172	21	14	2	12	232	29	6	0	24
53	6	13	3	19	113	14	5	2	3	173	21	17	0	15	233	29	8	2	27
54	6	16	1	22	114	14	8	0	6	174	21	19	2	18	234	29	11	1	2
55	6	18	3	25	115	14	10	2	9	175	22	2	0	21	235	29	13	3	5
56	7	1	2	0	116	14	13	0	12	176	22	4	2	24	236	29	16	1	8
57	7	4	0	3	117	14	15	2	15	177	22	7	0	27	237	29	18	3	11
58	7	6	2	6	118	14	18	0	18	178	22	9	3	2	238	30	1	1	14
59	7	9	0	9	119	15	0	2	21	179	22	12	1	5	239	30	3	3	17
60	7	11	2	12	120	15	3	0	24	180	22	14	3	8	240	30	6	1	20

TABLE SHOWING WEIGHT OF CROP PER ACRE—*continued.*

Weight per Area.	Weight per Acre.			
lb.	Tons	cwt.	qr.	lb.
241	30	8	3	23
242	30	11	1	26
243	30	14	0	1
244	30	16	2	4
245	30	19	0	7
246	31	1	2	10
247	31	4	0	13
248	31	6	2	16
249	31	9	0	19
250	31	11	2	22
251	31	14	0	25
252	31	16	3	0
253	31	19	1	3
254	32	1	3	6
255	32	4	1	9
256	32	6	3	12
257	32	9	1	15
258	32	11	3	18
259	32	14	1	21
260	32	16	3	24
261	32	19	1	27
262	33	2	0	2
263	33	4	2	5
264	33	7	0	8
265	33	9	2	11
266	33	12	0	14
267	33	14	2	17
268	33	17	0	20
269	33	19	2	23
270	34	2	0	26
271	34	4	3	1
272	34	7	1	4
273	34	9	3	7
274	34	12	1	10
275	34	14	3	13
276	34	17	1	16
277	34	19	3	19
278	35	2	1	22
279	35	4	3	25
280	35	7	2	0
281	35	10	0	3
282	35	12	2	6
283	35	15	0	9
284	35	17	2	12
285	36	0	0	15
286	36	2	2	18
287	36	5	0	21
288	36	7	2	24
289	36	10	0	27
290	36	12	3	2
291	36	15	1	5
292	36	17	3	8
293	37	0	1	11
294	37	2	3	14
295	37	5	1	17
296	37	7	3	20
297	37	10	1	23
298	37	12	3	26
299	37	15	2	1
300	37	18	0	4
301	38	0	2	7
302	38	3	0	10
303	38	5	2	13
304	38	8	0	16
305	38	10	2	19
306	38	13	0	22
307	38	15	2	25
308	38	18	1	0
309	39	0	3	3
310	39	3	1	6
311	39	5	3	9
312	39	8	1	12
313	39	10	3	15
314	39	13	1	18
315	39	15	3	21
316	39	18	1	24
317	40	0	3	27
318	40	3	2	2

Weight per Area.	Weight per Acre.			
lb.	Tons	cwt.	qr.	lb.
319	40	6	0	5
320	40	8	2	8
321	40	11	0	11
322	40	13	2	14
323	40	16	0	17
324	40	18	2	20
325	41	1	0	23
326	41	3	2	26
327	41	6	1	1
328	41	8	3	4
329	41	11	1	7
330	41	13	3	10
331	41	16	1	13
332	41	18	3	16
333	42	1	1	19
334	42	3	3	22
335	42	6	1	25
336	42	9	0	0
337	42	11	2	3
338	42	14	0	6
339	42	16	2	9
340	42	19	0	12
341	43	1	2	15
342	43	4	0	18
343	43	6	2	21
344	43	9	0	24
345	43	11	2	27
346	43	14	1	2
347	43	16	3	5
348	43	19	1	8
349	44	1	3	11
350	44	4	1	14
351	44	6	3	17
352	44	9	1	20
353	44	11	3	23
354	44	14	1	26
355	44	17	0	1
356	44	19	2	4
357	45	2	0	7
358	45	4	2	10
359	45	7	0	13
360	45	9	2	16
361	45	12	0	19
362	45	14	2	22
363	45	17	0	25
364	45	19	3	0
365	46	2	1	3
366	46	4	3	6
367	46	7	1	9
368	46	9	3	12
369	46	12	1	15
370	46	14	3	18
371	46	17	1	21
372	46	19	3	24
373	47	2	1	27
374	47	5	0	2
375	47	7	2	5
376	47	10	0	8
377	47	12	2	11
378	47	15	0	14
379	47	17	2	17
380	48	0	0	20
381	48	2	2	23
382	48	5	0	26
383	48	7	3	1
384	48	10	1	4
385	48	12	3	7
386	48	15	1	10
387	48	17	3	13
388	49	0	1	16
389	49	2	3	19
390	49	5	1	22
391	49	7	3	25
392	49	10	2	0
393	49	13	0	3
394	49	15	2	6
395	49	18	0	9
396	50	0	2	12

Weight per Area.	Weight per Acre.			
lb.	Tons	cwt.	qr.	lb.
397	50	3	0	15
398	50	5	2	18
399	50	8	0	21
400	50	10	2	24
401	50	13	0	27
402	50	15	3	2
403	50	18	1	5
404	51	0	3	8
405	51	3	1	11
406	51	5	3	14
407	51	8	1	17
408	51	10	3	20
409	51	13	1	23
410	51	15	3	26
411	51	18	2	1
412	52	1	0	4
413	52	3	2	7
414	52	6	0	10
415	52	8	2	13
416	52	11	0	16
417	52	13	2	19
418	52	16	0	22
419	52	18	2	25
420	53	1	1	0
421	53	3	3	3
422	53	6	1	6
423	53	8	3	9
424	53	11	1	12
425	53	13	3	15
426	53	16	1	18
427	53	18	3	21
428	54	1	1	24
429	54	3	3	27
430	54	6	2	2
431	54	9	0	5
432	54	11	2	8
433	54	14	0	11
434	54	16	2	14
435	54	19	0	17
436	55	1	2	20
437	55	4	0	23
438	55	6	2	26
439	55	9	1	1
440	55	11	3	4
441	55	14	1	7
442	55	16	3	10
443	55	19	1	13
444	56	1	3	16
445	56	4	1	19
446	56	6	3	22
447	56	9	1	25
448	56	12	0	0
449	56	14	2	3
450	56	17	0	6
451	56	19	2	9
452	57	2	0	12
453	57	4	2	15
454	57	7	0	18
455	57	9	2	21
456	57	12	0	24
457	57	14	2	27
458	57	17	1	2
459	57	19	3	5
460	58	2	1	8
461	58	4	3	11
462	58	7	1	14
463	58	9	3	17
464	58	12	1	20
465	58	14	3	23
466	58	17	1	26
467	59	0	0	1
468	59	2	2	4
469	59	5	0	7
470	59	7	2	10
471	59	10	0	13
472	59	12	2	16
473	59	15	0	19
474	59	17	2	22

Weight per Area.	Weight per Acre.			
lb.	Tons	cwt.	qr.	lb.
475	60	0	0	25
476	60	2	3	0
477	60	5	1	3
478	60	7	3	6
479	60	10	1	9
480	60	12	3	12
481	60	15	1	15
482	60	17	3	18
483	61	0	1	21
484	61	2	3	24
485	61	5	1	27
486	61	8	0	2
487	61	10	2	5
488	61	13	0	8
489	61	15	2	11
490	61	18	0	14
491	62	0	2	17
492	62	3	0	20
493	62	5	2	23
494	62	8	0	26
495	62	10	3	1
496	62	13	1	4
497	62	15	3	7
498	62	18	1	10
499	63	0	3	13
500	63	3	1	16
501	63	5	3	19
502	63	8	1	22
503	63	10	3	25
504	63	13	2	0
505	63	16	0	3
506	63	18	2	6
507	64	1	0	9
508	64	3	2	12
509	64	6	0	15
510	64	8	2	18
511	64	11	0	21
512	64	13	2	24
513	64	16	0	27
514	64	18	3	2
515	65	1	1	5
516	65	3	3	8
517	65	6	1	11
518	65	8	3	14
519	65	11	1	17
520	65	13	3	20
521	65	16	1	23
522	65	18	3	26
523	66	1	2	1
524	66	4	0	4
525	66	6	2	7
526	66	9	0	10
527	66	11	2	13
528	66	14	0	16
529	66	16	2	19
530	66	19	0	22
531	67	1	2	25
532	67	4	1	0
533	67	6	3	3
534	67	9	1	6
535	67	11	3	9
536	67	14	1	12
537	67	16	3	15
538	67	19	1	18
539	68	1	3	21
540	68	4	1	24
541	68	6	3	27
542	68	9	2	2
543	68	12	0	5
544	68	14	2	8
545	68	17	0	11
546	68	19	2	14
547	69	2	0	17
548	69	4	2	20
549	69	7	0	23
550	69	9	2	26
551	69	12	1	1
552	69	14	3	4

TABLE SHOWING WEIGHT OF CROP PER ACRE—*continued.*

Weight per Area.	Weight per Acre.				Weight per Area.	Weight per Acre.				Weight per Area.	Weight per Acre.				Weight per Area.	Weight per Acre.			
lb.	Tons	cwt.	qr.	lb.	lb.	Tons	cwt.	qr.	lb.	lb.	Tons	cwt.	qr.	lb.	lb.	Tons	cwt.	qr.	lb.
553	69	17	1	7	613	77	8	3	19	673	85	0	2	3	733	92	12	0	15
554	69	19	3	10	614	77	11	1	22	674	85	3	0	6	734	92	14	2	18
555	70	2	1	13	615	77	13	3	25	675	85	5	2	9	735	92	17	0	21
556	70	4	3	16	616	77	16	2	0	676	85	8	0	12	736	92	19	2	24
557	70	7	1	19	617	77	19	0	3	677	85	10	2	15	737	93	2	0	27
558	70	9	3	22	618	78	1	2	6	678	85	13	0	18	738	93	4	3	2
559	70	12	1	25	619	78	4	0	9	679	85	15	2	21	739	93	7	1	5
560	70	15	0	0	620	78	6	2	12	680	85	18	0	24	740	93	9	3	8
561	70	17	2	3	621	78	9	0	15	681	86	0	2	27	741	93	12	1	11
562	71	0	0	6	622	78	11	2	18	682	86	3	1	2	742	93	14	3	14
563	71	2	2	9	623	78	14	0	21	683	86	5	3	5	743	93	17	1	17
564	71	5	0	12	624	78	16	2	24	684	86	8	1	8	744	93	19	3	20
565	71	7	2	15	625	78	19	0	27	685	86	10	3	11	745	94	2	1	23
566	71	10	0	18	626	79	1	3	2	686	86	13	1	14	746	94	4	3	26
567	71	12	2	21	627	79	4	1	5	687	86	15	3	17	747	94	7	2	1
568	71	15	0	24	628	79	6	3	8	688	86	18	1	20	748	94	10	0	4
569	71	17	2	27	629	79	9	1	11	689	87	0	3	23	749	94	12	2	7
570	72	0	1	2	630	79	11	3	14	690	87	3	1	26	750	94	15	0	10
571	72	2	3	5	631	79	14	1	17	691	87	6	0	1	751	94	17	2	13
572	72	5	1	8	632	79	16	3	20	692	87	8	2	4	752	95	0	0	16
573	72	7	3	11	633	79	19	1	23	693	87	11	0	7	753	95	2	2	19
574	72	10	1	14	634	80	1	3	26	694	87	13	2	10	754	95	5	0	22
575	72	12	3	17	635	80	4	2	1	695	87	16	0	13	755	95	7	2	25
576	72	15	1	20	636	80	7	0	4	696	87	18	2	16	756	95	10	1	0
577	72	17	3	23	637	80	9	2	7	697	88	1	0	19	757	95	12	3	3
578	73	0	1	26	638	80	12	0	10	698	88	3	2	22	758	95	15	1	6
579	73	3	0	1	639	80	14	2	13	699	88	6	0	25	759	95	17	3	9
580	73	5	2	4	640	80	17	0	16	700	88	8	3	0	760	96	0	1	12
581	73	8	0	7	641	80	19	2	19	701	88	11	1	3	761	96	2	3	15
582	73	10	2	10	642	81	2	0	22	702	88	13	3	6	762	96	5	1	18
583	73	13	0	13	643	81	4	2	25	703	88	16	1	9	763	96	7	3	21
584	73	15	2	16	644	81	7	1	0	704	88	18	3	12	764	96	10	1	24
585	73	18	0	19	645	81	9	3	3	705	89	1	1	15	765	96	12	3	27
586	74	0	2	22	646	81	12	1	6	706	89	3	3	18	766	96	15	2	2
587	74	3	0	25	647	81	14	3	9	707	89	6	1	21	767	96	18	0	5
588	74	5	3	0	648	81	17	1	12	708	89	8	3	24	768	97	0	2	8
589	74	8	1	3	649	81	19	3	15	709	89	11	1	27	769	97	3	0	11
590	74	10	3	6	650	82	2	1	18	710	89	14	0	2	770	97	5	2	14
591	74	13	1	9	651	82	4	3	21	711	89	16	2	5	771	97	8	0	17
592	74	15	3	12	652	82	7	1	24	712	89	19	0	8	772	97	10	2	20
593	74	18	1	15	653	82	9	3	27	713	90	1	2	11	773	97	13	0	23
594	75	0	3	18	654	82	12	2	2	714	90	4	0	14	774	97	15	2	26
595	75	3	1	21	655	82	15	0	5	715	90	6	2	27	775	97	18	1	1
596	75	5	3	24	656	82	17	2	8	716	90	9	0	20	776	98	0	3	4
597	75	8	1	27	657	83	0	0	11	717	90	11	2	23	777	98	3	1	7
598	75	11	0	2	658	83	2	2	14	718	90	14	0	26	778	98	5	3	10
599	76	13	2	5	659	83	5	0	17	719	90	16	3	1	779	98	8	1	13
600	75	16	0	8	660	83	7	2	20	720	90	19	1	4	780	98	10	3	16
601	75	18	2	11	661	83	10	0	23	721	91	1	3	7	781	98	13	1	19
602	76	1	0	14	662	83	12	2	26	722	91	4	1	10	782	98	15	3	22
603	76	3	2	17	663	83	15	1	1	723	91	6	3	13	783	98	18	1	25
604	76	6	0	20	664	83	17	3	4	724	91	9	1	16	784	99	1	0	0
605	76	8	2	23	665	84	0	1	7	725	91	11	3	19	785	99	3	2	3
606	76	11	0	26	666	84	2	3	10	726	91	14	1	22	786	99	6	0	6
607	76	13	3	1	667	84	5	1	13	727	91	16	3	25	787	99	8	2	9
608	76	16	1	4	668	84	7	3	16	728	91	19	2	0	788	99	11	0	12
609	76	18	3	7	669	84	10	1	19	729	92	2	0	3	789	99	13	2	15
610	77	1	1	10	670	84	12	3	22	730	92	4	2	6	790	99	16	0	18
611	77	3	3	13	671	84	15	1	25	731	92	7	0	9	791	99	18	2	21
612	77	6	1	16	672	84	18	0	0	732	92	9	2	12	792	100	1	0	24

—*C. H. Schwass, Fields Division, Wellington.*

Manurial Value of Burnt Bones.—Bone-char is a good phosphatic fertilizer, containing some 60 per cent. of tricalcic phosphate. The nitrogenized organic matter contained in bones is expelled by the burning, however, and any action which may accrue from the decomposing effect of gelatine is also lost. It is thought that in ordinary bones this decomposing effect helps to make the phosphoric acid (P_2O_5) more available.

SEASONAL NOTES.

THE FARM.

TOP-DRESSING OF PASTURES.

TOP-DRESSING with rock phosphate, Ephos, and other slow-acting fertilizers should now be pushed along. June is also a good month for applying basic slag. Superphosphate will be better used a month or two later.

It is not advisable to use raw rock phosphate on land that has been recently limed. The liming reduces the acidity of the soil and makes the already slow-acting phosphate slower still. As a general rule, where lime has been applied superphosphate should be used. Where no liming has been done basic super, basic slag, or mixtures of half super and half rock phosphate may be applied. Where the rainfall is light super or basic super should give best results. In wetter situations basic slag or one of the other mixtures mentioned could be used. In average districts the end of June or early in July will be early enough for these manures. As a rule, it is best not to apply super before July, and in the later districts August is early enough.

The farmer must use discretion as to the quantity of fertilizer to apply. This will depend upon the condition of his pasture. If it has been well treated and appears to be in good heart 1½ cwt. to 2 cwt. should be ample. If, on the other hand, the land has been neglected and the grass and clovers are weak it will pay to apply from 3 cwt. to 4 cwt. per acre. Top-dressing should start at a stage in the life of the pasture when it is still good; if this is done a small quantity applied each year will give better results than a heavier dressing one year and none the next. Pastures should be well tripod-harrowed both before and after top-dressing. It is better to keep stock off the top-dressed area for a week or two after applying the fertilizer, or until there has been a good shower or two.

CULTURAL OPERATIONS.

No opportunity should be lost of turning over any land still required for spring sowings. For such crops as mangolds, carrots, and potatoes autumn or early winter ploughing is most important. In the case of lea land, as long as the weather is fair the plough can generally be kept going, as it requires a considerable rainfall to make such land too wet.

Where the soil is not too wet and cold cereals and tares sown early in June may still make sufficient growth to be useful for spring feeding. A good mixture is 1½ bushels of winter tares to 1½ bushels of oats, barley, or rye-corn, with 1½ to 2 cwt. of superphosphate per acre. Care should be taken not to drill too deeply at this season. The addition of a few pounds of Western Wolths or Italian rye-grass is an improvement.

FEEDING OF FODDER CROPS.

Fodder crops sown in March and April will be now throwing an appreciable amount of feed, which can be judiciously grazed down, care being taken not to poach the soil in wet weather. Special care should be taken with newly-sown permanent pastures; sheep should be kept off them as far as possible, and the grazing should not be so close as to bare the young and tender roots to the frosts.

Roots should, as far as possible, be fed out on fields affected with grass-grub or where the grass requires building up. The tramping of the stock will destroy a great many of the grubs, and the necessary hay will supply a considerable amount of grass seed to build up the pastures. Great care should be taken not to feed out swedes on land intended to be cropped with turnips or swedes during the following season or two. Crops are commonly more or less affected by club-root or dry-rot, and if the roots are fed out on a clean field the latter becomes contaminated, with the result that the succeeding crop is liable to be badly diseased. This does not apply to mangolds or carrots, which are not affected by this disease.

It is advisable if the best use is to be made of roots that they be lifted and stacked in a dry position convenient to the feeding-place. In districts where severe frosts are experienced a covering of straw is necessary. The practice of some farmers of allowing cows access to turnips in the field without furnishing any dry fodder must be strongly condemned. In the feeding of all roots plenty of hay or straw should be given with them.

Where mangolds are grown in large areas for sheep they may be harrowed out. If any old broken-mouthed ewes are available it is a good plan to put them on to eat off the tops before harrowing. The ewes will do quite well on the tops, and having few teeth they will not hurt the bulbs.

Dairy cows should get special attention at this period, as it is the time for their annual recuperation, and unless well treated they cannot be expected to give good returns next season. It is false economy to pinch a cow in the off-season; if there is to be a shortage of feed let it be later when the cow has got rid of her calf and the days are getting longer.

LUCERNE.

Land being prepared for lucerne should be thoroughly limed before the end of June. One ton of crushed limestone (carbonate of lime) or $\frac{3}{4}$ cwt. of burnt lime should prove a suitable dressing.

Where a seed-crop is required next season the stand should at this period receive a top-dressing of quick-acting phosphate such as super, or on the colder and wetter soils a manure containing nitrogen as well as phosphate—for example, blood-and-bone. The periodical liming of lucerne stands is an important factor in prolonging their life.

STUMPING BUSH-BURN PASTURES.

In bush or erstwhile bush districts a profitable occupation for the winter months is stumping. There are many thousands of acres of old bush-burn pasture now sorely in need of renovation, and while much

can be done by top-dressing there can very often be no real improvement till the land has been cleared of stumps, roots, and logs, so that the plough and the mower can be got to work. A notable example is to be seen in many parts of North Auckland where paspalum is the predominant grass. If the valuable land now growing mainly rushes and coarse paspalum were stumped, drained, and ploughed a good paspalum and clover sward could be established and kept in a highly productive condition by judicious mowing, disking, and manuring. Hay and ensilage could then be saved—and winter and spring feed is generally an urgent problem in paspalum country.

GENERAL OFF-SEASON WORK.

When weather conditions do not allow of cultivation being carried on there remains an immense amount of work that is really essential for the well-being of the farm. Pastures should be harrowed consistently, with the tripods for preference, except on very light soils, where they are apt to prove too severe. Fences should be carefully inspected and strengthened, new fences erected, gates rehung where necessary, and gateways made up with metal, clinkers, or similar material. The amount of time and energy wasted by teams and herds in negotiating boggy gateways and lanes is quite appreciable.

Open drains should be cleaned out and relevelled, and it is a good plan to substitute covered drains, of manuka, pungas, or tiles, wherever possible, in order to obviate the risk of losing stock. Small covered drains are also invaluable for freeing paddocks from excessive moisture without inconvenience to tillage-work. On impervious clay soils, and low-lying alluvial lands in particular, drainage is one of the biggest factors in successful farming.

—*Fields Division.*

THE ORCHARD.

PRUNING OPERATIONS.

ORCHARDS will now be clear of all fruit and in readiness for the commencement of pruning operations, which will take precedence over all other work.

Although pruning of fruit-trees has been practised for many years it is quite safe to assert that there is yet a great deal to learn. It is only by careful study and watching the result of each season's operations that any advancement can be made and the best results obtained. There are general basic principles that should largely govern the action taken by every commercial fruitgrower, whereas in details there is a possibility of a very wide range of action whereby good results may be attained. One has to consider the variety, class of soil, climatic conditions, &c. It is poor practice to accept any given and definitely set line upon which to work.

At the time of planting it is necessary to cut back, in the first place, so as to enable root and top growth to commence on equal terms, and also to enable a good foundation to be established. If this is not done it is quite impossible to expect that trees will be built up of such a character that they will yield large crops of fruit. The crop is the

ultimate aim of every fruitgrower, and he should therefore cut fairly hard for the first two or three years, this will enable him to lay a good foundation. Once this has been obtained the aim should be to prune in such a manner as to steadily build up the tree in the main leaders, while at the same time giving due consideration to the development of its fruiting-wood. To continue pruning a vigorous-growing tree hard after it has obtained fairly liberal dimensions is to delay the fruiting-period. The best practice to adopt after the tree has been built up is that which will maintain an even balance between wood-growth and fruit-bearing. While there are some who neglect to carry out any system of pruning, there are others who carry this important operation to excess on certain kinds of trees after the latter have reached the age when they should be carrying good crops of fruit.

No time should be wasted on any trees which are intended for working over later in the season, beyond heading them off a few inches above the point where it is intended to work them. This can be done at any time after the foliage has fallen, but should not be left too late. Any tree of outstanding merit, such as strong growth, combined with good bearing qualities, freedom from disease, &c., should be carefully noted. From this class of tree any wood for reworking purposes should be taken.

PLANTING.

Where conditions are favourable and the land has been well prepared planting can now be commenced. If the land is at all wet, however, this work is much better deferred until later, as the roots would only become water-logged, and this would hold the trees back in the coming spring. Where trees have been received from the nursery the bundles should be opened, and the trees placed in a trench until the land is in a suitable condition for planting.

MARKETING.

Fruit in store should be closely watched, as there are indications that some varieties are not keeping very well. This applies in the main to fruit not in cool store. All varieties as they mature should be placed on the market. No fruit should be marketed without repacking if it has been in the cases more than a few weeks, as nothing will give buyers a worse impression than to find lines of fruit offered for sale with a proportion of rotten or partly rotten fruit in each case. Growers will be well repaid for the extra amount of labour entailed in repacking.

—L. Paynter, Orchard Instructor, Christchurch.

CITRUS-CULTURE.

Although it is not well to anticipate trouble, it is reasonable to expect that some frosts will again be experienced in the citrus-growing districts during the ensuing winter months, and precautions should be taken. The grower should, firstly, ensure against the loss of mature fruit that may be hanging on the trees at the time. It is well, therefore, to take immediate steps to remove all fruit that has reached that stage of maturity which will allow of its being efficiently cured. Further, the precautions should be taken of covering young citrus-trees by means of a rough frame of manuka, or other available

material, made bell-tent fashion over the tree, and covered on the top and at least one side—the sunny side—with scrim or light sacking. These coverings should, if possible, be constructed in such a manner as to allow of their being lifted and lowered as required.

No doubt a number of growers will be desirous of extending their groves by new plantings this season, and also it is possible that entire new areas may be planted in this class of fruit. Final preparation of the land should now receive attention, and be completed before the winter rains set in. The writer is entirely in favour of spring planting of citrus-trees in the Auckland Province, but the land should be thoroughly prepared, and the trees set in position at such a time as will ensure their receiving the benefit of the heavy spring rains.

In the selection of the young trees, it is desirable that the purchaser should see exactly what he is purchasing from the nurseryman, in order that the very best stock may be procured. Only young trees showing vigorous growth and possessing a strong root-system should be placed in a permanent position in the orchard. Due regard should be given to the stocks upon which the various varieties are worked. The sweet-orange stock is the one most preferred at the present time, although there is yet large room for experimental work in regard to the selection of the best class of stock or stocks for planting on the various classes of gum-lands to be found in Auckland Province. Those intending planters who receive their young trees from the nursery during the autumn or winter months should take the necessary precaution of heeling them in in a sheltered position, and keeping them covered from possible danger of frost-injury.

STRAWBERRY-GROWING.

It will generally be found that the soil is in excellent condition to receive strawberry-plants during the earlier part of this month, and those growers who have, for one reason or another, not yet carried out their planting should see that this work is completed at the earliest possible date. As pointed out in previous notes, it is absolutely essential that only strawberries of strains known to be a commercial success should receive the attention of any grower.—

—J. W. Collard, Orchard Instructor, Auckland.

POULTRY-KEEPING.

CARE OF THE BREEDING-HENS.

THE selection of the most desirable hens for the coming breeding season should have been made before this. Indeed, such birds should be receiving special attention in order that they may resume egg-laying as soon as possible, and be in the pink of condition at mating-time. In this connection I cannot urge too strongly the advisability of providing the birds with a free range, preferably on grass runs, wherever possible to do so. In this way they not only secure natural exercise but natural food as well—two great essentials for the maintenance of good health. The birds should be fed and managed in such a way

that while being in a healthy state they are at the same time in a more or less hard, lean condition. Now that they are in a non-productive condition there will be a tendency for them to become overfat, a condition which should be avoided at all costs in the future breeding-hen. Eggs produced from overfat stock may hatch fairly well, but the great danger lies in the difficulty of rearing the chicks. I have frequently been called upon to advise regarding heavy mortality in brooder chicks, only to find that the cause of the trouble could be traced to the overfat condition of the parent stock.

The feeding of the birds intended as breeders, and also after they are mated, is all-important. It will generally be found that stronger chicks are produced from the feeding of a variety of whole grains, such as wheat, oats, maize, &c., for both morning and evening meals. Care must be taken that this is fed in deep litter at all times, so as to induce a maximum of exercise. A chick is made up of many parts. It is therefore essential that the mother hen be provided with a variety of foodstuffs, in order that she may secure and impart to her offspring the elements necessary for the development of a sturdy, vigorous chick. The provision of ample green-stuff should not be forgotten. It is one of the chief foodstuffs for promoting good health, while a liberal supply of fresh water, gravel grit, and crushed oyster-shell are of equal importance. Just before or when the birds are producing eggs for reproductive purposes they should be fed and managed in the most natural manner possible. Any attempt to secure high egg-yields by including in the ration a large proportion of forcing-food such as meat will generally result in weak fertility, poor hatches, and the production of chicks that are difficult to rear.

TUBERCULOSIS.

Tuberculosis—which is usually termed by poultrymen "going light," or "spotted liver"—is a contagious disease in poultry. It affects both old and young stock, and is no doubt the most serious disease that the poultry-keeper has to guard against, not only owing to its fatal effects, but also owing to there being no curative methods which can be employed to combat it. Most other troubles affecting poultry, especially where the cause is first removed, will yield to some extent to curative treatment; but this one is entirely different, the only effective way of fighting it being to prevent it.

The disease is most common at this period of the year, for the reason that the great majority of the adult stock are in the poorest condition. This is a result of an exhausting laying season, together with the effect of the moulting process, which in itself makes a severe demand on the system of the bird. The present is therefore a time to watch closely for the evils arising from any constitutional weakness in the stock and from improper methods of management; it is now that the birds are in their most susceptible state should they come in contact with the infection. It is thus a mistake to allow the birds to become run down or to neglect them in any way merely because they are not in a laying condition. If they are to have the power to resist disease their health must be as good as possible. Especially should the diet be nourishing and fed with a free hand, and a plentiful supply of green-stuff is imperative. While good feeding and special care and management are important factors in warding off disease, the first

precaution lies in the maintenance of constitutional vigour in the flock. Apart altogether from the value of outstanding vigour for the maintenance of egg-laying, this quality must be present in both males and females if disease is to be kept at bay. No bird, however well it has laid, should be bred from if it gives the slightest evidence of a weakened constitution.

A further valuable precaution is to see that the young stock are reared under the best possible conditions, in order that there may be no check in their development. The poorly reared bird is always susceptible to every passing ailment. In this connection the necessity must be strongly urged of providing a clean run—one that has been spelled for some time, and for preference that has been turned over, well limed, and sown down. It is essential that the quarters be maintained always in a thoroughly sanitary state. This means frequent cleaning disinfection, and, above all, the avoidance of poultry-sick soil. Overcrowding should also be avoided at all costs, and it is important that the sleeping-quarters be well ventilated without draughts. In addition, the house should be opened up in front and arranged in such a way that the sunlight will penetrate to practically all parts of it. Of course, local conditions must always be taken into consideration in regard to the open space allowed in the front of the house. It should, however, always be remembered that fresh air and sunshine are the greatest enemies of disease and parasitic life. Tuberculosis is most common where the birds are kept in dark, damp, or badly ventilated houses, especially where cleanliness is not strictly observed.

The symptoms of tuberculosis in poultry are a listless appearance and rapid emaciation, usually accompanied with diarrhœa followed by a pale-coloured excrement. The bird shows no inclination to mix with other members of the flock, and when it walks there is generally a limp of one leg. Should there be any indication of the presence of the disease the suspected cases should be isolated and placed in a clean house and run. If any of these birds are subsequently considered to be affected a *post mortem* examination should be made. In a case of tuberculosis the liver, which is the chief organ to become affected, will present a mass of cheese-like nodules or tubercles, varying in size from a pin-head to a pea or even larger. The spleen is sometimes affected in a similar manner. Small nodules may also be found in the lungs and in various parts of the digestive tract.

Any bird showing such symptoms should be promptly killed and the carcase burnt. When it is not convenient to properly burn the dead birds they should be buried deeply, so that they will not be dug up by dogs or when the ground is being worked. This precaution should also be taken with birds that die from any cause. If possible the whole of the stock in the run where the affected birds came from should be removed to fresh quarters, and everything favourable for the development of the disease should be removed, and thorough methods of disinfection resorted to. The run should also be dug over and limed, and the house well sprayed with a strong disinfectant.

As the chief source of infection is through the digestive tract, and as the droppings of an affected bird contain enormous numbers of tubercle bacilli, it will be readily seen how easy it is for food to become contaminated and a healthy bird to become affected. If the disease makes its appearance in a flock the risks of infection may therefore be

minimized by providing all the food in troughs, and by removing these immediately the birds have finished their meal. No food should be fed in the litter until such time as indications point to the disease being stamped out. It is also a good plan to keep the birds confined to the house. In this way the source of infection is not only reduced, but a good opportunity is also afforded for turning the run over and sowing it down as a means of sweetening it.

Prevention is the most effective means of fighting disease in poultry generally. The poultry-keeper who breeds his stock on sound principles, who keeps the houses clean, dry, properly ventilated without draught, and free from vermin, who avoids poultry-sick soil, and who provides the right class of food with a free hand, need have little fear of disease.

—F. C. Brown, Chief Poultry Instructor.

THE APIARY.

HIVE ENTRANCES AND STANDS.

PERHAPS at no other season is it so necessary to keep the hive-entrances absolutely free of obstruction as at present. Vegetation during the next few months is rarely dry even in fine weather, and when the bright sunshine of early winter days tempts the bees to a flight the apiarist should see that they run no risk of being caught in long grass, weeds, &c., thereby becoming chilled and losing all power of ever re-entering the hives. By removing such growth from around the hives now the entrances will remain clear for the next few months; and if the ground is treated with a dressing of agricultural salt in sufficient quantity before the spring growth starts there should be no trouble of this sort throughout the ensuing season.

In no case should hives be placed directly on the ground, or the bottom-boards will soon rot and have to be replaced. The hives should stand sufficiently high above the ground to avoid dampness, and it is an excellent plan to stand them on four half-bricks placed one at each corner of the bottom-board. Should the apiary be in a permanent situation, no better plan can be followed than to provide concrete hive-stands. These stands have been used in New Zealand for a number of years, and have saved the users a great deal of labour by preventing the growth of weeds and by affording protection against insect pests. They are comparatively expensive to lay down in the first place, but, being permanent, will remain in position indefinitely. If such stands are adopted the concrete should extend a few inches in front of the alighting-boards, in order to prevent vegetation from growing too close to the entrances of the hives. In all cases the hives should have a slight cant towards the entrances, so as to permit of the water leaving the bottom-boards readily. The presence of moisture will lead to much loss to the beekeeper, besides causing the hives to become sour and foul-smelling.

SHELTER.

With the approach of winter and its frequent rough weather the apiarist should turn his attention to the all-important question of shelter. Even if this provision entails a certain amount of outlay, it

will in the end prove one of the greatest economies. Not only is the danger obviated of having hives blown over and lids removed, with the resultant losses by cold and exposure, but it will be found in the spring that the well-sheltered, warmly situated colonies have wintered not only with a minimum of losses but also with a minimum consumption of stores. The colony which has to winter in a cold exposed situation will have to consume far more honey to keep itself alive than the colony whose compact cluster is unaffected by cold and damp. In the latter case, also, the bees will have a far greater degree of vitality with which to face the strain of spring breeding. Bees require just as much attention and care at the approach of winter as at the beginning of summer, and the careful beekeeper will see that they are treated so that, as far as his hives are concerned, he can regard southerly gales, snowstorms, and severe frosts with equanimity.

SAVING THE WAX.

The annual wastage of wax is very great, and it is safe to assert that if more care were exercised by beekeepers there would be ample for local requirements. No industry can be carried on successfully without ample supplies of raw material, yet beekeepers are annually wasting or destroying by fire large quantities of raw material which should go to cheapen the cost of production and add to the profits of the apiary. There are quite a number of comb-foundation manufacturers in the Dominion, and, to their credit, it may be said that they are on the whole turning out an article quite equal to the imported. Their main difficulty is in obtaining beeswax to carry on, while their customers are disposing otherwise of the raw material which could be converted into foundation. Manufacturers are working up wax into foundation at 8d. to 9d. per pound. This is reasonable when the skill and time necessary to manufacture a good article is taken into consideration. The saving to the beekeeper who has his wax converted is approximately 1s. 6d. per pound, and where increase is desired, or in the case of the less fortunate beekeeper who has to treat for disease, the saving is at once apparent.

After the honey crop is disposed of and the bees are settled snugly in their winter quarters the beekeeper should give attention to clarifying his wax. Where a solar extractor has been used during the summer it will be a simple matter to collect the cakes of wax which have been melted in this manner and reduce them to one or two large cakes; but where any number of combs are to be treated a wax-press is an almost indispensable article in the apiary equipment. For handling wax in large quantities the press now known as the Root wax-press is best. No special building is needed for wax-melting; an ordinary wash-house answers the purpose admirably. A cold day should be chosen for the operation, since nothing excites the bees during the off-season like the smell of hot wax.

Commencing operations, fill the copper half full of water, and when this is heated place the combs—which must have been removed from the frames—in the hot water. Have a strong stand ready to support the wax-press, and inside this place a kerosene heater, so arranging it that the flame comes into direct contact with the bottom of the press. Fill the water compartment of the press with boiling water, which the

heater will now keep boiling, and in the perforated basket of the press place a coarse scrim bag, large enough to reach to the bottom of the basket. The combs in the copper should be stirred with a stick until the wax is all melted, and the contents of the copper—water and wax—should then be ladled into the scrim bag in the press. The top of the bag should now be folded so as to allow one or more of the wooden "followers" belonging to the press to be placed on top of it, and when the screw is placed in position a stream of water and wax will immediately commence to flow from the outlet provided in the press. A kerosene-tin or similar vessel should be placed in position under the outlet.

Two precautions are necessary in using a wax-press. Pressure should at all times be applied with caution. Until the flow from the press slackens the screw should not be turned, and when it becomes necessary to apply pressure this should be done without appreciable effort. The screw should always turn easily. It will be found that if this advice is taken the maximum of wax will be obtained with very little risk to the machine. Another point to be borne in mind is that only a comparatively small quantity of water and wax must be put into the bag at each ladling. It is difficult to estimate exactly how much to treat at once, so much depends on the proportions of wax and water, but on no account attempt to fill the scrim bag at one operation. When the wax and water cease to run from the outlet the bag should be removed and the slum-gum emptied out before the press is required to deal with any more wax.

As the copper will, of course, contain a great deal of water, it is an excellent plan to keep a kerosene-pump in the vessel placed to receive the contents of the press. If this is sunk to the bottom of the vessel it will draw off a great deal of the water, leaving the wax, which will, of course, be on top, untouched. This will result in the wax being gathered in far larger cakes than if several vessels are used. The wax should be set aside to cool as gradually as possible, this being best achieved by covering the tin containing it with corn-sacks or similar material. The gradual cooling helps to clarify the wax. When the cakes are quite cold they should be taken out of the tin and carefully scraped.

The tin should next be washed out and partly filled with clean hot water, the cake of wax replaced, and the whole gradually heated until the wax is once more melted. After this second process the whole should be slowly cooled as before, and when the wax is once more removed and scraped it will have reached its commercial form. The wax-press and copper should be cleansed while still hot. The water should be emptied out of its compartment in the press at once, and the press placed to drain in order to prevent rust. The slum-gum must be gathered up and burnt, and the bag washed and dried for future use.

THE ANNUAL CONFERENCE.

The annual Dominion conference of beekeepers will be held at Christchurch on 4th, 5th, and 6th June. It is expected that delegates from all branches of the National Beekeepers' Association of New Zealand will be present. Papers dealing with various phases of the industry will be read, and in addition demonstrations with beekeepers' appliances will be given.

—E. A. Earp, Senior Apiary Instructor.

THE GARDEN.

VEGETABLE-CULTURE.

THE preparation of land for crops referred to in last month's notes should now receive every attention, specially those areas to be planted in onions, early potatoes, or peas. On well-drained land in the warmer localities these crops are best sown as early as possible in the month of July. On the heavier flat lands care must be taken to avoid unduly hurrying the preparation and planting. Great injury is done by working such land when it is too wet, or planting before it is sufficiently warm.

The seed requirements for the season should also have careful consideration now. Seeds of a kind look very much alike to the casual observer, but the experienced grower and the commercial grower especially know the importance of seeds of a good "strain." Germination is usually good, though often weak, but manures and well-prepared land are wasted unless seeds that are clean and of the best strain are planted. Tomato-seed, for example, varies greatly in strain; it may also be affected with the bacterial "black-stripe" disease, for which there is little remedy. It is not uncommon to come across instances where the best of land has been given every attention and the crop skillfully handled, but the result has been unsatisfactory for this reason alone.

As to varieties, it is best to keep in the main to those which experience has proved suitable to the respective districts, although the progressive grower will always try a little seed of a new variety if it is properly recommended.

Small private gardens are more easily managed and a proper rotation observed if, instead of growing all kinds of vegetables every season, a selection is made. Land that has been heavily manured and has carried winter cabbage, broccoli, and sprouts should during the following season be planted in celery and root crops, to be followed the next year by such shallow-rooting subjects as peas, beans, onions, and salads. It is in this way that very small areas may be made wonderfully productive at the lowest cost of material and labour.

What has been said of seed applies very largely to potato sets: it is worth while going to some trouble to get good stocks, and they should be got without delay. Potatoes for planting are best stored in a *light*, airy place, which will check sprouting; in fact, for the earlier crops they are best spread in a single layer. Stored in this way the sets ripen, and any growth made is strong and stout and in every way desirable.

SUNDRY FRUITS AND NUTS.

There are many kinds of fruits and nuts in short supply, both for private home use and market purposes. Almonds, cherries, chestnuts, currants, figs, filberts, gooseberries, persimmons, quinces, and passion-fruit are some of them. They all deserve the careful consideration of the private grower, and many of them of the commercial grower also. It is not at all uncommon in some parts of the country to come across chestnuts and filberts growing on grassy hillsides with very little attention,

and carrying good crops. Persimmons of good varieties crop well here, and when in proper condition are considered by many to be among the most delicious fruits grown. Any of the foregoing may be planted now on suitable land, except perhaps passion-fruit, which, like some other smaller plants, is best left till later.

FLOWERS, SHRUBS, AND TREES.

During the winter interval it is well to consider plans for the coming season before the memory of the last one fades. There is a tendency perhaps for the planting of annuals to become somewhat stereotyped. A number of such plants are suited to sea-side and inland places, light and heavy land. A closer study of the seed catalogues will reveal many excellent alternative plans. A little less variety would improve many schemes, and nearly all would benefit from a greater use of those quieter foliage and flowering plants—gypsophila, for instance—that, although modest in themselves, do so much to blend and harmonize the brighter colours. The popular "Bonfire" salvia gave a much enhanced display this season in a garden where it was associated with the small white perennial aster. Results depend on careful planning as much as anything, and the best results are then often obtained very simply. The zinnia has been much improved of late, and its rich quiet half-tones are worth the consideration of any one who has a piece of good land to spare in the garden for this purpose.

While detached trees or groups of shrubs on a lawn add much to the interest of a garden and afford variety, the effect is lost if suitable spaces do not intervene. Too often such is not the case, and trees and shrubs are planted with a rather monotonous regularity. Such places may now be adjusted by removing some of the plants together in groups and leaving others in a suitable isolation. Quite large shrubs may be removed with safety at this season if the work is properly carried out. It is necessary to have a well thought-out scheme before commencing the work.

Any further planting of trees and shrubs may now be carried out as long as the ground is sufficiently dry, in which case they can hardly be planted too firmly. Avoid crowding the better class of shrubs; the evergreens necessary to create an environment, however, may very well touch and blend. The present is a suitable time for any pruning necessary among ornamental trees and shrubs; this attention is too often neglected in the home garden. A specimen conifer is allowed to develop a double lead until it is almost too late to remove it, or grosser shrubs are allowed to overgrow the better kinds. Most flowering-shrubs would be improved by thinning out the more crowded branches.

—W. C. Hyde, Horticulturist.

Registration of Stallions.—A draft Bill providing for the inspection and registration of stallions, prepared by the Department of Agriculture, has been approved by the Board of Agriculture and recommended for enactment this year. The Minister of Agriculture hopes it will be found possible to deal with the Bill during the coming session.

SPECIMEN OF NEW ZEALAND APPLE-EXPORT LABEL, SEASON 1924.

The large figures on right are the broker's registered number and those on left the grower's. The small figures in lower right corner denote the number of apples packed in case. The label is coloured and fits the end of the bushel case.

Wheat and Oats Threshings.—Returns of actual threshings up to the end of March received by the Government Statistician from threshing-mill owners showed that until then 3,067,790 bushels of wheat and 1,227,444 bushels of oats had been threshed out. The average yields per acre in cases where particulars of areas were furnished (covering 99 per cent. of total threshings) worked out at 24·55 bushels for wheat and 31·42 bushels for oats. The figures for the Canterbury and Otago Land Districts respectively were as follows: Canterbury—Wheat, 2,563,102 bushels threshed, averaging 25·18 bushels per acre; oats, 517,520 bushels threshed, averaging 27·20 bushels per acre. Otago—Wheat, 374,259 bushels, averaging 21·78 bushels per acre; oats, 331,668 bushels, averaging 36·96 bushels per acre.

British Market for Peas and Beans.—The following information was cabled by the High Commissioner, London, on 10th May: *Peas*—Consumptive demand better for all descriptions of blue. Present values are—Japanese on passage, £21 10s. per ton c.i.f.; April-May shipments, £20. Small Baltic April-May shipments, £20. Dutch hand-picked, April-May shipments, £21 10s. Tasmanian on passage, £20; April-May shipments, £18 10s.; spot selling at £21 10s. to £22 ex store. New Zealand spot nominally £17 to £19. Supplies of maple plentiful, and New Zealand excessive. English selling at 55s. per quarter. New Zealand offered at 70s. to 80s. Tasmanian best, 85s. to 90s. ex store. *Beans*—Market quiet, with fair trade for choice winter and spring crops at 49s. 6d. and 60s. per quarter. Small round, 70s. to 75s.

WEATHER RECORDS: APRIL, 1924.

Dominion Meteorological Office.

GENERAL SUMMARY.

THE month of April opened with dull, misty, and foggy weather, with the barometer reading about normal in all parts of the Dominion. Without change in this respect a deluge of rain fell in several parts of the North Island on the 3rd. A newspaper reported that the River Puhoi rose 16 ft. in an hour. There were also heavy falls of rain in Taranaki, Waihi, Auckland, and along the Wanganui River. Further heavy falls took place between the 4th and 8th, when the barometer was at its highest—30·58 in. at Wellington.

Fair weather prevailed for a short time, but the barometer fell smartly in the South on the 10th, and was followed by showery conditions in the west coast and southern districts until the 14th. Variable breezes and fair though somewhat changeable skies were experienced until the 22nd, when a westerly storm-area made its appearance, bringing heavy rain in Westland and Otago. Rainy weather followed in the North next day, with strong northerly winds. A rather sudden but mild southerly on the 24th accounted for a temporary improvement, but the closing days of the month were unsettled and stormy, especially in and southward of Cook Strait.

The rainfall was generally above the average, but deficient in North Canterbury, and the temperatures were mild for the season.

—D. C. Bates, Director.

RAINFALL FOR APRIL, 1924 AT REPRESENTATIVE STATIONS.

Station.	Total Fall.	Number of Wet Days.	Maximum Fall.	Average April Rainfall.
North Island.				
	Inches.		Inches.	Inches.
Kaitaia	6·62	16	1·36	3·55
Russell	5·37	16	0·87	3·39
Whangarei	9·65	19	2·11	4·95
Auckland	11·56	19	4·32	3·34
Hamilton	9·52	20	2·82	3·64
Kawhia	7·66	12	1·82	4·75
New Plymouth	8·29	14	2·34	4·57
Inglewood	11·99	16	2·82	8·39
Whangamomona	14·68	14	4·00	6·68
Tairua, Thames	20·38	16	6·00	5·88
Tauranga	9·23	18	2·05	4·47
Maraehako Station, Opotiki ..	5·56	14	1·76	5·22
Gisborne	5·35	12	1·79	4·26
Taupo	5·94	14	2·54	3·95
Napier	3·05	8	1·35	2·17
Maraekakaho Station, Hastings ..	2·86	15	1·01	3·14
Taihape	4·10	14	1·32	3·37
Masterton	2·08	11	0·51	3·18
Patea	5·14	11	1·28	3·95
Wanganui	6·55	8	3·51	3·59
Foxton	3·27	9	0·86	2·57
Wellington	2·73	8	1·07	3·84
South Island.				
Westport	9·15	16	1·55	6·50
Greymouth	9·17	19	2·14	8·83
Hokitika	21·22	19	4·68	9·31
Arthur's Pass	24·08	11	8·90	17·64

RAINFALL FOR APRIL, 1924—*continued.*

Station.	Total Fall.	Number of Wet Days.	Maximum Fall.	Average April Rainfall.
South Island—continued.				
	Inches.		Inches.	Inches.
Okuru, Westland	23·46	16	8·00	13·67
Collingwood	9·96	15	2·22	8·07
Nelson	5·92	12	2·40	2·93
Spring Creek, Blenheim ..	2·95	10	2·08	1·91
Tophouse	7·76	9	2·21	4·03
Hanmer Springs	4·21	8	1·40	3·27
Highfield, Waiau	1·01	6	0·43	2·85
Gore Bay	0·46	6	0·17	2·02
Christchurch	0·76	9	0·35	1·91
Timaru	1·90	8	1·08	1·49
Lambrook Station, Fairlie ..	3·94	6	2·26	2·00
Benmore Station, Omarama ..	5·62	10	2·55	2·52
Oamaru	0·85	5	0·38	1·76
Queenstown	5·62	13	1·08	2·92
Clyde	3·26	10	1·68	1·34
Dunedin	1·96	7	..	2·72
Gore	2·11	13	0·47	3·26
Invercargill	2·96	17	2·22	4·43

IMPORTATION OF FERTILIZERS: MARCH QUARTER.

FOLLOWING are the importations of fertilizers into New Zealand for the quarter ended 31st March, 1924: *Sulphate of Ammonia:* United Kingdom, 81 tons; Australia, 61 tons: total, 142 tons. *Nitrate of Soda:* Chile, 40 tons. *Basic Slag and Thomas Phosphate:* United Kingdom, 6,847 tons; Belgium, 1,155 tons; Netherlands, 10 tons: total, 8,012 tons. *Bonedust:* India, 310 tons; Australia, 624 tons: total, 934 tons. *Guano and Rock Phosphate:* United Kingdom, 5 tons; New Caledonia, 1,198 tons; Nauru Island, 13,165 tons: total, 14,368 tons. *Phosphates, other:* United Kingdom, 10 tons. *Kainit:* United Kingdom, 199 tons; Germany, 210 tons: total, 409 tons. *Sulphate of Potash:* United Kingdom, 50 tons; Germany, 83 tons: total, 133 tons. *Potash, other:* United Kingdom, 30 tons; Germany, 25 tons: total, 55 tons. *Sulphate of Iron:* Australia, 34 tons.

INVENTIONS OF AGRICULTURAL INTEREST.

APPLICATIONS for patents, published with abridged specifications in the *New Zealand Patent Office Journal* for 17th April and 1st May, 1924, include the following of agricultural interest:—

No. 48018: Cream-separator; L. Rasch, Christiania, Norway. 49800: Flax-treatment; W. F. Lietz, Auckland. 50126: Frozen-carcase transferring and bagging means; S. H. Higgs and E. P. O'Donnell, Wellington. 50276: Milk-agitator; L. H. Clapham, Tokomaru. 49139 and 50499: Cow-milker; E. H. Wright, Morrinsville. 50523: Sheep-shear; F. G. W. Bristow, Sydney. 51471: Cream, &c., pasteurizing; J. O'Connell and H. H. Kerr, Kensington, Vic. 51563: Milk or cream cooler; J. D. Hunter and J. Moore, Dunedin. 51566: Horse shoeing and treating apparatus; F. A. Kerr, Auckland. 51660: Cattle-injection apparatus; A. Coombes, Mataura. 51741: Cream-cooler; E. D. Berry, Palmerston North.

Copy of full specifications and drawings in respect of any of the above may be obtained from the Registrar of Patents, Wellington, price 1s.

ANSWERS TO INQUIRIES.

IN order to ensure reply to questions, correspondents must give their name and address, not necessarily for publication, but as a guarantee of good faith. Letters should be addressed to the Editor.

SHEEP ATTACKED BY BLOW-FLY.

PALMER BROS., Whangamata :—

I should be glad if you would inform me whether there is a reliable dressing which will prevent blow-flies from attacking sheep. We have a few stud merinos, and in spite of every attention the flies will not leave them alone. We have tried preparations, but without any good results.

The Live-stock Division :—

There is no known dressing which when applied will act as a permanent remedy against the attacks of blow-fly. Any dressing applied must be repeated at intervals, especially in wet weather, as a damp condition of the wool attracts the fly. Attention to the wool of the hindquarters—crutching if necessary—is essential. As a preventive of the fly "striking," probably the best results follow spraying or saturation with a solution of dipping-powder, taking care that the dip reaches to the skin by using a powerful spray-pump. The sheep should be examined again in a few days, in order to destroy any maggots which may have escaped. The sheep should be kept away from sheltered, shady places, where, as a rule, the fly is more prevalent.

ERADICATING YARROW BEFORE LUCERNE.

A. H. ROWE, Tauranga :—

Would you kindly indicate the best method of eradicating yarrow in an area intended for lucerne; or would the lucerne be able to combat the intruder if sown in the autumn? The spring-tooth cultivator will not bring the yarrow to the surface after fallowing for two months, the root being too soft and brittle.

The Fields Division :—

Yarrow is a hardy strong-growing weed, with a deep taproot, so that it hardly seems likely that the lucerne would make headway against it. The first step in eradication is deep ploughing, followed by the cultivator and tine harrows immediately after, while the soil is loose. Roll the yarrow up with the chain harrows and cart it off, repeating the operations till the paddock is clean, finally going over the ground and picking out by hand any plants remaining. If you have no time to do this at present, fallow this month with persistent cultivation, and grow next season mangolds, potatoes, or maize, which should be thoroughly cleaned by intercultivation and hand-hoeing. As regards autumn sowing, you would probably find that the yarrow did more growing in the winter than the lucerne.

BROKEN-WINDED HORSES.

H. H. W., Waiomiko :—

About six months ago one of my draught horses developed a nasty dry cough and became very thick in the wind, and now he can scarcely work at all; even when he is not doing anything his sides heave like a horse that has just finished a heavy pull. Another horse started to go exactly the same about three months ago, but besides the cough he runs at the nose a good deal. I grow and cut my own chaff, but last season, on account of the wet weather, the oats were badly damaged before we could get them harvested, with the result that the chaff was dusty and musty. I fed it to the horses with maize, and they ate it quite all right. I will be much obliged if you will tell me the cause of the trouble and what to do for the horses.

The Live-stock Division :—

Your horses are apparently suffering from broken wind—the result of improper feeding. When this trouble is well established little can be done to cure it, but proper attention to feeding will alleviate the symptoms. The animals should be fed fairly frequently and in small quantities, so that overloading of the stomach is prevented. Any hay which is fed should be thoroughly clean and free from dust, and should be dampened before use and preferably fed from the floor. See that they are watered before feeding. As irregularity in the action of the bowels frequently accompanies this condition, if would be as well to give a dose of raw linseed-oil two or three times a month.

LIMING FOR WESTLAND SOILS.

T. STONE, Puketoi :—

In reference to the article on page 28 of the *Journal* for January last, concering the liming of Westland soils, I would be glad to know whether raw ground limestone is meant or burnt limestone.

The Fields Division :—

In all cases recorded in the article, excepting the Westport district, ground burnt lime was used. In Westport slaked burnt limestone was used, there being no machinery at the local lime-kilns for grinding purposes. Under this method the limestone after being burnt is put out on the field in small heaps, allowed to air-slake, and is then spread on the land. It has practically the same action as ground burnt lime. Raw ground limestone (carbonate of lime) has been procurable in Westland only during the past twelve months; where used it is giving very satisfactory results.

CONTAGIOUS VAGINITIS IN COWS.

C. D. F., Ormondville :—

A number of my cows are affected with vaginitis, and with the exception of one I believe them to be in calf. I am treating them as advised in the *Journal* for April, 1923. Is it any use treating in-calf cows, or is the flushing of the passage likely to cause them to slip? Is it correct that a yellowish discharge should come away after washing? Will an affected cow sometimes carry her calf the full period, or is she likely to slip at any time or only during the first two months? My eighteen-months in-calf heifers are also affected. Is it wise to treat them?

The Live-stock Division :—

So long as symptoms of the trouble persist it would probably be advisable to continue with the treatment. Do not, however, insert the tubing too far or make your material too strong, or you might induce straining. With regard to the discharge you mention, this is not always present. Affected cows may carry their calves to the full time, and do not always slip. We should advise you to treat your heifers also.

GROWING GLADIOLUS FROM SEED.

O. W. GREEN, Tarakohe :—

Would you please let me know whether *Gladiolus* will grow from seed, and the best method to plant same?

The Horticulture Division :—

Gladiolus grows readily from seed. The seed should be kept until the spring, when it may be sown in seed-boxes or a sunny border outside. Seedlings usually flower in two or three years' time.

CONSOLIDATED INDEX OF THE JOURNAL.

ATTENTION is drawn to the publication of a consolidated index of the *New Zealand Journal of Agriculture*, covering the first ten years—twenty half-yearly volumes—June, 1910, to June, 1920. There has been a considerable demand for such an index, and it will be found very useful for reference and other purposes. The index, which is the same size as the *Journal* (royal octavo) and comprises 60 pages, may be obtained on application to the Publisher, Department of Agriculture, Wellington, price 2s. (remittance with order).

PAN-PACIFIC FOOD CONSERVATION CONFERENCE.

THIS conference, to be held under the auspices of the Pan-Pacific Union, at Honolulu, from 31st July to 14th August, 1924, will comprise the following groups: (1) International Agreements regarding Fisheries; (2) Economic Entomology; (3) Plant Pathology; (4) International Quarantine Policies; (5) Crop Production and Improvement; (6) Forestry; (7) Climatology; (8) Transportation and Distribution of Food Products; (9) Topography—Land and Sea; (10) Animal Husbandry.

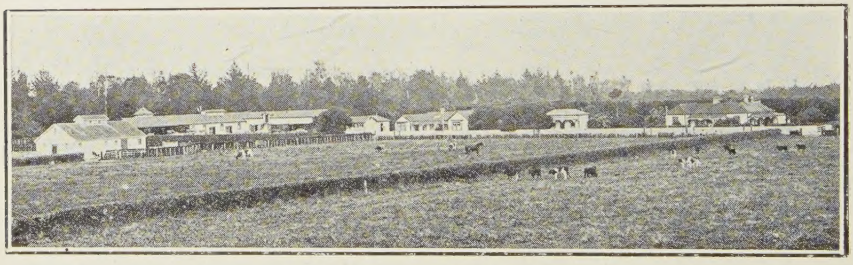
It will be seen that the range of subjects is very comprehensive, and includes most branches of knowledge which are of vital interest to New Zealand producers and to those engaged in giving scientific advice. The Director, Mr. A. H. Ford, is anxious to obtain papers to be read before the conference in ample time to have them printed for circulation at the meetings. The chairman for New Zealand, Mr. B. C. Aston, P.O. Box 40, Wellington, will be pleased to receive the titles of any papers which authors may wish read or the papers themselves.

FORTHCOMING WINTER SHOWS.

Southland A. and P. Association: Invercargill, 21st to 23rd May.
Waikato Winter Show Association: Hamilton, 27th May to 3rd June.
Otago A. and P. Association: Dunedin, 3rd to 6th June.
Auckland Winter Exhibition: Auckland, 10th to 28th June.
Manawatu A. and P. Association: Palmerston North, 17th to 20th June.
Wellington Winter Show Association: Wellington, 5th to 12th July.

(Agricultural and Pastoral Association secretaries are invited to supply dates and location of their shows.)

Winter Farm-schools.—Enrolments for the school to be held at Dargaville from 30th June to 4th July are to be made with Mr. A. R. Valder, Mangawhare, Northern Wairoa—not with the Instructor in Agriculture, Auckland, as stated last month.



HOMESTEAD, ETC., AT CENTRAL DEVELOPMENT FARM, WERAROA.